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TEXAS AGRICULTURAL EXPERIMENT STATION

A. B. CONNER, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

FORTIETH ANNUAL REPORT
1927

IMPERIAL BUREAU
10 AUG. 1928
OF MYC

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
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J. S. Mogford, M. S., *Associate Professor of Agronomy*

†As of May 1, 1928. *Dean, School of Veterinary Medicine.
**In cooperation with U. S. Department of Agriculture.
***In cooperation with the School of Agriculture.

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FORTIETH ANNUAL REPORT, 1927

A. B. CONNER, Director

The Texas Agricultural Experiment Station is one of the main divisions of the Agricultural and Mechanical College of Texas. Its function is agricultural research. It receives its support through appropriations made by the Legislature and through further endowments made by the Federal Congress in the Hatch, Adams, and Purnell Acts. These acts passed by the Federal Congress for the support of agricultural research provide an equal amount of money to each state to be expended through the agricultural experiment station.

The establishment and support of the Agricultural Experiment Station is based upon the need for agricultural research supporting sound teaching and sound extension work of the Agricultural and Mechanical College and other institutions engaged in any way in the dissemination of agricultural knowledge and upon the further need for the study of important agricultural problems which have to do with the full development of the agricultural resources of the State and Nation.

The agricultural resources of Texas exceed the agricultural resources of any other state and in the full development of these resources basic facts and principles must be established if the development is to proceed along sound, constructive, and permanent lines. The support of the research work of the Agricultural Experiment Station is considered as an investment made toward developing fully the agricultural resources of Texas and thus reaping a full measure of our agricultural opportunities.

RESEARCH AND AGRICULTURAL DEVELOPMENT

Texas is an Empire with vast agricultural resources as yet only partially developed. Our cattle population, exceeding that of any other state, is not fully utilized in keeping with our opportunities, since through the shipment of feeder cattle to other states, we allow the feeding and finishing phase of this important industry to enhance the wealth of other sections; whereas, our fifty million bushels of grain sorghum, our hundred million bushels of corn, our million tons of cottonseed meal, and other feeds produced annually should be used in a large measure in feeding and finishing our own cattle.

Our cotton crop, amounting to approximately 40 per cent of the Nation's output, is hampered by the cotton root rot disease, which takes an annual toll estimated at from twenty-five to fifty million dollars and which affects the acre yield and the net profit accruing to the grower. Such losses place a heavy burden upon the cotton growers of

Texas and the remedy lies in the development of full and complete knowledge, through research, of the life history, means of spread, and the behavior of this fungus under field conditions from which may be developed an effective method of partial or complete control of this disease of cotton.

The rainfall on our farms, needed there for increasing acre yields, is allowed to run off into the rivers carrying with it the cream of soil fertility, thus allowing the wastage of both water and soil fertility through a lack of a full knowledge of how most effectively to curtail these losses.

Our soil fertility problem, particularly in the great Blacklands region, is not yet solved and we do not yet know the best means of maintaining and building up soil fertility. We are unable to explain the lack of a consistent response by field crops to commercial fertilizers in the great Blacklands region. Our knowledge of the soil fertility problem under Western conditions is very limited and will remain so until research has developed information concerning the chemical and bacterial conditions which affect soil fertility.

The horticultural possibilities of Texas have been developed only in a very limited way. The conditions surrounding citrus production in the Lower Rio Grande Valley and the environment necessary for the production of the maximum number of fruits preferred by the market have not been fully worked out. The possibility of date culture in Southwestern Texas offers an opportunity for developing a new agricultural resource for that part of Texas. The pecan industry, an important industry in Texas, is affected by the lack of a full knowledge as to the best methods and practices for the production of the most profitable crop. A vast development in our horticultural resources awaits a better understanding of the problems confronting the industry.

Economic problems of importance concern the growers of all crops, and basic knowledge as to marketing facilities which the growers of all products should enjoy is limited. We have not yet determined the most efficient cropping practices and organizations of the different farm enterprises, and, in fact, a host of important and fundamental problems confront the agricultural research worker.

Researches are necessary to make available fundamental facts for improving the health and well-being of citizens, that assistance may best be given those who assume the chief responsibility for the welfare of the children through increased knowledge of nutrition, clothing, and proper environment. The best utilizations of food, raiment and shelter for the promotion of health, maximum efficiency, and appreciation of values are prime factors in our welfare and therefore researches in rural home problems become of the greatest importance.

The soil survey, which provides the citizenship with information as to the nature and character of the soils of the State, is yet in the preliminary stages with approximately 30 per cent of the counties of the State surveyed and mapped in detail at the present time. There is great

need for speeding up the soil survey work and providing the farmer with a full knowledge of the nature, character, and uses of his land.

The Agricultural Experiment Station is, within its means, vigorously attacking the numerous problems in a systematic way, and yet the demands for more information of a specific character are very urgent. The following report is a summary of the progress made during the past year on the many problems under investigation by the Agricultural Experiment Station, each of which has an intimate relation to the development of the resources and wealth of Texas.

Procedure in the Study of Problems

In connection with the study of the agricultural problems confronting the different regions of Texas and the State as a whole, it is the policy and practice of the Agricultural Experiment Station to select definite problems of particular importance to the State or to an agricultural region and to develop what is known as a project and an outline setting forth the main objectives in making the study as well as the general method of procedure in carrying out the study to obtain data from which conclusions may be safely drawn.

After the judicious selection of a project and the preparation of a statement or outline setting forth the objectives in view and the procedure to be followed in the study, the only important consideration thereafter is to have a capable man in charge of the work who will be able to exercise ingenuity in the aggressive study of the problem and who will exercise the patience necessary to stick to the problem and the study of the major objectives until definite information is secured. Such work may in many cases require a period of eight or ten years before conclusive results are obtainable, and the work, therefore, necessarily requires patience.

ORGANIZATION AND WORK

The Texas Agricultural Experiment Station System comprises the Main Station, at College Station, and appropriate divisions and scientific laboratories and experiment substations and field laboratories located in several regions of the State, as follows:

Divisions

Administration
Veterinary Science
Chemistry
Horticulture
Range Animal Husbandry
Entomology
Agronomy
Plant Pathology and Physiology
Farm and Ranch Economics
Rural Home Research
Soil Survey
Botany
Swine Husbandry
Dairy Husbandry
Poultry Husbandry
Feed Control Service
Main Station Farm
Agricultural Engineering
Publications

Substations

No. 1. Beeville, Bee County
No. 2. Troup, Smith County
No. 3. Angleton, Brazoria County
No. 4. Beaumont, Jefferson County
No. 5. Temple, Bell County
No. 6. Denton, Denton County
No. 7. Spur, Dickens County
No. 8. Lubbock, Lubbock County
No. 9. Balmorhea, Reeves County
No. 10. College Station, Brazos County
No. 11. Nacogdoches, Nacogdoches County
No. 12. Chillicothe, Hardeman County
No. 14. Sonora, Sutton-Edwards County
No. 15. Weslaco, Hidalgo County
No. 16. Iowa Park, Wichita County

Research Field Laboratories

State Apicultural Research Laboratory, San Antonio, Bexar County
Research Queen Yard, San Antonio
Research Bee Outyard, Dilley, Frio County
Research Bee Outyard, Roxton, Lamar County
Research Bee Outyard, Seguin, Guadalupe County
Loin Disease Research Field Laboratory, Bammel, Harris County

Station Lands

The following table shows the lands owned and operated by the Agricultural Experiment Station System of the Agricultural and Mechanical College of Texas, for agricultural research purposes:

	Acres of Land Devoted to Various Uses			
	Area	Cultivation	Pasture	Farmstead Roadways and Miscellaneous
Total	8,121.395	1,636.33	6,246.245	248.82
Main Station Farm	*127	82	26	19
Division of Veterinary Science	*141	5	130	6
State Apicultural Research Laboratory, San Antonio, Bexar County	10	4.5	4.5	1
Loin Disease Field Laboratory, Bammel, Harris County	†1400.9	0	1398.9	2
Substation No. 1, Beeville	151.5	104	25	22.5
2, Troup	152.6	62.5	84	6.1
3, Angleton	159.3	58	98	3.3
4, Beaumont	100	67	4	29
5, Temple	96	37	55	4
6, Denton	209.92	139	54	16.92
7, Spur	406.35	275	121.35	10
8, Lubbock	160	122	38	10
9, Balmorhea	200	80	110	10
10, College Station	‡901.8	240	630	31.8
11, Nacogdoches	81.6	35.4	36	10.2
12, Chillicothe	100	85	5	10
14, Sonora	3461.63	59.93	3381.7	20
15, Weslaco	100	72	3	25
16, Iowa Park	161.795	108	41.795	12

*Included in the main tract of College land.
†Leased land.
‡Includes 636 acres of the College's main tract and 265.8 acres purchased later for research purposes.

For the State fiscal year ended August 31, 1927, the inventories of the Texas Station totaled $995,371.76, exclusive of the property of the

College now being used for Station purposes. This property, which consists of land at College Station, two brick buildings on the Campus, all carried on the College inventory and not repeated in the Station inventory, is valued at $169,449.69. The total value of all property being used at this time for the purposes of the Agricultural Experiment Station System is $1,164,821.45.

VETERINARY SCIENCE

Projects

1. Loin Disease of Cattle; Adams fund; H. Schmidt, leader.
2. Swamp Fever of Horses and Mules; Hatch and State funds; H. Schmidt, leader.
3. Infectious Bovine Abortion Studies; Hatch and State funds; H. Schmidt, leader.
4. Swellhead of Sheep and Goats; Adams fund; H. Schmidt, leader.
5. Stomach Worms in Sheep and Goats; State and local funds; W. L. Black, Veterinarian, Substation No. 14, leader.
6. Duration of Immunity to Texas Fever; Hatch and State funds; R. P. Marsteller, leader.

Loin Disease of Cattle

In connection with the study of the loin disease problem, it was observed that many cows on the range in the loin disease area chewed bones or consumed other putrid carcass material, and upon further observation, it was found that animals fed a dairy ration did not contract loin disease. Accordingly, it was assumed that the disease might be caused by the consumption of putrid carcass material on the prairie caused by the desire of the animals for certain elements not obtainable in the vegetation on the range.

Bone meal and fine salt mixtures were fed to animals and the results compared with the results from animals receiving no bone meal and fine salt mixtures. The results, briefly, have shown that it is possible to practically eliminate bone chewing on the range by feeding bone meal and fine salt mixtures, and that when bone chewing and the consumption of putrid carcass material are eliminated, the trouble from loin disease is practically eliminated.

The results have further shown that animals receiving a mixture of bone meal and fine salt have produced profitable gains over animals not receiving it in addition to the ration obtained under range conditions. The percentage of calf-crop has been increased by feeding bone meal and fine salt mixture, and the weight and growth of the calves have been much increased over calves from cows receiving no bone meal and fine salt mixture supplementing the range feed.

It was also evident from these comparative results that no cases of creeps appeared among animals receiving bone meal and fine salt mixture, and 30 per cent suffered from creeps more or less severely in the

case of the control cows nursing calves and receiving no bone meal and fine salt mixture.

On obtaining consistent results showing the value of supplying the mineral element to animals on the range, examinations were made of the grasses collected on the grounds of the Loin Disease Field Laboratory and these, when analyzed, proved to be deficient in phosphorus and lime, and also below cottonseed hulls in protein content. There is without question a definite relation between the content of the grasses on the range and the shortage of mineral elements received by the animals, which, in turn, is responsible for the craving for the needed elements.

While good results have been obtained from feeding a mixture of bone meal and fine salt, there is some evidence that supplementing this mixture with a small amount of cottonseed meal will further increase the growth and gains made by animals on this range. In fact, the work thus far has emphasized the importance of and the necessity for supplementary range feeding on this range if cattle production is to be profitable and if the loin disease is to be evaded.

It has been determined that loin disease can be reproduced artificially at will through our knowledge that the disease is caused by an anaerobic organism, which has not yet been isolated. The organism, however, has been grown in cultures and used to reproduce the disease when cultured material was given to healthy animals. Moreover, the organism has been filtered out of the toxic cultures and the filtered solution used to successfully reproduce the disease, showing that the loin disease is due to a toxic substance produced by the organisms and not by the organisms themselves.

It is therefore apparent, as has been repeatedly pointed out in the past, that all carcass material is not toxic and all will not produce loin disease. Only in rare instances will carcass material produce loin disease. On the other hand, experiments to date have shown conclusively that carcass material that does produce the disease contains a toxic substance produced by an organism which lives in bones and other putrid carcass material. The work at the Loin Disease Field Laboratory and at College Station is proceeding along the lines of isolating the particular organism causing the disease and in rounding out a complete knowledge of it.

Swamp Fever of Horses and Mules

Only two cases of Swamp Fever of mules were under treatment during the year. One of the mules has had two injections of Bayer 205 (Naganol), the last on August 8, 1926. Subsequently this mule showed temperature reactions. For this reason the mule was placed on a course of tartar emetic. Beginning August 1, 1926, an injection of a 3 per cent solution in water was given, of which 25 to 40 cubic centimeters were given every other day, ten injections being given in all. Apparently no cure was effected by this treatment, for ten days after the last injection the animal showed another reaction which lasted for five days.

The second mule had not been subjected to drug treatment, although

he had shown four distinct reactions. During the last reaction in question he was placed on a course of treatment of tartar emetic. A three per cent solution of tartar emetic was chosen, and intravenous injections were made every other day, 25 to 40 cubic centimeters being given at each injection. Twelve injections in all were made. No reaction has occurred since this course of treatment was concluded. Not enough time has elapsed to determine clinically whether or not a cure has been effected by this treatment.

Infectious Bovine Abortion Studies

Vaccination of the cows in the dairy herd of the Feeding and Breeding Station with live cultures of Brucella abortus (Bang) was continued. All cows were given 40 cubic centimeters of a 30-day-old live culture, five cubic centimeters being injected at each of four different points on both sides of the neck, eight injections in all. No abscesses were observed. The animals were bred not earlier than 60 days after the injection. The same process was repeated before the cows were bred a second time. During the period from September 1, 1926, to August 31, 1927, twelve cows which received the first injection calved, and one aborted. During the same period, 21 cows which had received the second treatment calved, and one aborted. Thus, of the 35 cows vaccinated and receiving either one or two treatments, 33 calved during the year, and two aborted. There were 35 conceptions during the year, which, according to the breeding sheets, required 46 services, or 1.3 services per conception. These 35 conceptions resulted in 33 viable calves and two abortions, or six per cent abortions during the year. This percentage falls considerably below even the lowest percentage reported for the ten years previous to the time that vaccination was practiced, and is about the same percentage that occurred following the vaccination in the herd last year. The data also indicate that the breeding efficiency of the herd has not suffered from the vaccination.

Swellhead of Sheep and Goats

It was planned to carry the work under this project at Substation No. 14, Sonora; however, no active work has been done there during the past year. Some work on the project was done at the Main Station.

During the past winter, attention was called to a goat disease around Marfa, Texas, which could not be recognized from the description furnished by the County Agent. Similar reports had come from Fort Davis and from DeLeon. A request brought in two live goats by express, which showed typical symptoms of swellhead, with the exception that no swelling of the head had occurred. Since the cause of swellhead of sheep and goats is not known at this time, and since the disease had never been transmitted artificially to other healthy animals, we, of course, are not in position to state whether or not a swelling of the head is characteristic and pathognomonic for swellhead. We need, moreover, not be concerned with the absence of this symptom in the

goats under consideration, because our results obtained are so important and favorable and the disease under consideration was so widespread that it does not make any difference whether we call the trouble swellhead or something else. Suffice it to say that the post-mortem lesions in all their details were the same as those found in swellhead.

These two goats were put in a 12x12 stall together with one healthy goat from our flock. Four days later one of the goats was unable to get up and was so weak that it was sacrificed for a post-morten examination. Cultures were made from the blood, the spleen, and the kidneys, both aerobic and anaerobic. Smears made from the spleen and kidneys and examined microscopically revealed streptococci in chains containing from two to sixteen elements. In some of these chains the organism appeared as very short rods. These streptococci were later found in pure culture in some of the anaerobic tubes made from the blood, spleen, and kidneys.

Three healthy goats from our own flock were inoculated with material taken from the above goat. One was inoculated with five cubic centimeters of blood subcutaneously; one was inoculated intraperitoneally with the extract of about six grams of spleen pulp, and one was inoculated subcutaneously with about 200 crushed lice which were found to be very numerous on the goat subjected to post-mortem. The goat inoculated with the crushed lice died some days later, with some anaerobic infection. The goat inoculated with the blood and the one inoculated with the spleen pulp showed no reaction.

The second sick goat was kept in contact with one of our healthy goats for a period of ten days, and finally recovered. Four days after our healthy goat was placed in contact with these goats it appeared to be sick and refused to eat and drink. It lost flesh rapidly, and in ten days it was so weak that it could no longer get up. It was taken to the laboratory for post-mortem examination and to be cultured. All cultures made were negative, as was also the post-mortem, with the exceptions of the bile, which was as clear as water.

On March 14, 1927, an aged healthy Angora goat was inoculated intravenously with four cubic centimeters of culture fluid of the streptococci isolated from the first animal posted. About twenty days later this animal appeared not to be doing well and soon refused to eat, although it had access to good grass and clover. The goat had a muco-purulent discharge from the nose and eyes, which dried to crusts. During the following days the animal grew rapidly worse, getting poorer every day and refusing to eat. It lay down a good deal and would eat oak leaves on April 12, but no grass, hay, or grain. On April 11 it was taken to the laboratory and cultures were made from its blood. Two days later it was decided to sacrifice the animal, and additional cultures were made from the blood, spleen, kidneys, and urine. The cultures from the liver, kidneys, and spleen did not show streptococci. Of the four tubes inoculated from the blood on April 11, one showed a streptococcus in pure culture. The other three tubes remained sterile. Post-

mortem lesions of this goat showed a bright red hemorrhagic area in the mesentery. The gall bladder contained about 7.5 cubic centimeters of bile which was as clear as water and contained only a small amount (10 cc.) of green pigment in the bottom. When the bile was removed from the gall bladder this mixed with the clear-as-water fluid and gave it a pale-green color. This pale green fluid did not give a bile-pigment reaction. No other gross lesions were observed.

On May 11 another Angora goat was inoculated intravenously with three cubic centimeters of culture fluid of the streptococcus isolated from the first goat posted. No symptoms of the disease were observed following this inoculation. On the same day another Angora goat was inoculated intravenously with four cubic centimeters of culture fluid of our streptococcus isolated from the blood of the first goat posted. No symptoms could be observed.

On April 8 another goat was inoculated intravenously with one and one-half cubic centimeters of culture fluid from a 25-day-old culture of the streptococci isolated from the first goat. On April 17-20, inclusive, the goat was observed to be lying down all day in the manger and appeared to be sick. Thereafter the animal appeared to improve and recovered.

On April 10 two other goats were received from the field, suffering from the same disease as the first two mentioned. Clinical symptoms, with the exception of the swelling of the head and post-mortem lesions, were indistinguishable from the swellhead of sheep and goats. These two goats were immediately put in contact with two healthy goats from our own flock. These two contact goats remained healthy.

On April 11 cultures were made from the blood of the two sick goats received on the previous day. Two days later one of the two goats was no longer able to get up and was, therefore, taken to the laboratory to be posted and to have cultures made from its internal organs and the urine. Streptococci in pure culture in some of the tubes were obtained from the liver, spleen, kidneys, blood, and urine. The second goat of the second shipment was posted on April 14 and cultures were made from the spleen, kidneys, blood, and urine. Of these cultures, those of the spleen, kidneys, and urine showed streptococci in pure culture in some of the tubes.

On April 22 a healthy Angora goat was inoculated intravenously with three and one-half cubic centimeters of culture fluid of a streptococcus culture obtained from the first goat of the second shipment. The inoculation was not successful.

On May 23, 1927, one of our healthy Angora goats was inoculated intravenously with two and one-half cubic centimeters of culture fluid from a streptococcus isolated from the first goat which had succumbed to an inoculation of the same. Our records show that a muco-purulent discharge was observed from the nose and the right eye, on May 26 and 27, which dried to a crust around the nose and below the eyes. On May 28 the goat was not feeding so well. Following this, the animal

began to slowly lose flesh and made an impression as though it was suffering from some chronic ailment. On June 20 cultures were made from the blood of this goat in brain media in cube liver bouillon, with negative results. On June 22 there was a marked mucous discharge from the eyes and nose, especially from the latter. On June 26 and 27 the animal did not eat. During the next two weeks it would eat rather irregularly and sparingly. The appetite of the animal remained at a low ebb until about July 12, when the records show that the animal was eating better again. From July 30 until the death of the animal on August 10, it refused to feed almost entirely. On August 10 cultures were again made from the blood in brain media in cube liver bouillon. On this day the animal was very weak and hardly able to stand. On August 11 it was found down and unable to get up. It was, therefore, carried to the laboratory and destroyed for post-mortem. No streptococci were found in the cultures made at post-mortem from the spleen, liver, kidneys, heart blood, and abdominal fluid, but two out of the six tubes of cube liver bouillon inoculated from the blood drawn on August 10 showed a streptococcus in pure culture. Post-mortem lesions in this goat were negative, with the exception of the bile, which was represented by a colorless fluid.

Stomach Worms of Sheep and Goats

The project on Stomach Worms of Sheep and Goats has been carried on at the Ranch Experiment Station, near Sonora, and progress has not been altogether satisfactory.

In view of the great interest taken in this project by the sheep and goat men of West Texas at this time, it is thought advisable to review all of the data collected by this Division during the last several years, so as to get a true inventory of what may be expected. This Division has worked especially with copper sulphate solutions and from time to time has tried other remedies recommended by other experiment stations, in order to check up with results reported. It should be stated definitely at this place that Black Leaf 40, as recommended, proved so toxic in our hands that we abandoned it after several trials. Similar experience was had with carbon tetrachloride, which has proved too toxic in our hands, so that we could not feel safe in recommending it. It must be noted, however, that the dose administered by us now appears to have been greatly in excess of the actual requirements, but even a reduction of 60 per cent in our dose has still proved unsatisfactory on account of the toxicity of the drug in some cases. Much work is still necessary on this drug in order to determine whether it can safely be used or not.

A summary of all the work done indicates that a one and three-fourths per cent solution of copper sulphate is 90 to 100 per cent efficient in 9 out of 14 cases, and practically ineffective in five cases. In 29 cases treated with a two per cent solution of copper sulphate only three cases were practically without effect, the others ranging from 75

to 100 per cent efficient. In a treatment of 17 cases with a three per cent solution of copper sulphate, one was 15 per cent effective, one 59 per cent effective, one 60 per cent effective, and all the rest 94 to 100 per cent effective.

These results indicate the persistence of ineffective cases, even when stronger solutions are used, and it may be that some other factor not yet determined is responsible for these ineffective cases.

Carbon tetrachloride in eight treatments has shown one 73 per cent effective, one 90 per cent effective, and all the rest 100 per cent effective. Here, as in the case of copper sulphate, there seems to be some tendency for the effects of this treatment to vary with different animals or under different conditions.

In a large number of animals treated with a one and three-fourths per cent solution of copper sulphate, and even a two per cent solution, not a single animal has died from copper sulphate poisoning. This work seems to indicate that copper sulphate in a one and three-fourths per cent solution is effective in killing stomach worms and will be a practical means of control, providing that we understand the factors responsible for the exceptional ineffective cases noted.

CHEMISTRY

Projects

1. Nutritive Values of Feeds; Adams fund; G. S. Fraps, leader.
2. Soil Studies; Adams fund; G. S. Fraps, leader.
3. Plants, Their Composition and Properties; Hatch and local funds; G. S. Fraps, leader.
4. Composition and Properties of Texas Soils; Hatch and local funds; G. S. Fraps, leader.
5. Human Food; Its Composition, Properties, Utilization, and Preservation; Hatch and local funds; G. S. Fraps, leader.
6. Feed Analyses and Investigations; Feed Control and local funds; G. S. Fraps, leader.
7. The Value of Sulphur to Texas Soils and Crops; cooperative study; funds provided by Freeport Sulphur Company; G. S. Fraps, leader.
8. Pecan Soils in Texas; State and local funds; G. S. Fraps and W. T. Carter, leaders.
9. Variation in Vitamine Content of Texas Foods; Purnell fund; G. S. Fraps, leader.
10. Nitrification. A Study of the Relation of Nitrification to Soil Fertility; Purnell fund; G. S. Fraps, leader.

Soils

A report on the study of the potash of Texas soils has been made in Texas Station Bulletin No. 355, "Relation of the Potash Removed by Crops to the Active, Total, Acid-soluble, and Acid-insoluble Potash of

the Soil." This work shows that the estimation of active potash gives the best idea of the possible deficiency of the soil for potash at the present time. The total potash and the acid-soluble potash were compared with the active potash on soils tested by means of pot experiments.

A bulletin is being prepared discussing the relation of water-soluble potash, potash soluble in ammonium chloride, and potash soluble in 12 per cent acid, as related to the active potash and the potash given up to plants in pot experiments.

Chemical analyses and pot experiments have been made upon a number of samples of typical soils. A bulletin is nearly ready for publication, dealing with the soils of Bowie, Denton, Freestone, and Red River Counties.

Feeds

Digestion experiments with sheep, chickens, and rats were continued. Nine experiments were made on hogs. The study of the digestibility of sugars, starch, pentosans, and other constituents of feeds was continued.

A bulletin is being prepared which contains the results of 63 digestion experiments with poultry, conducted by this Division, together with a compilation of all the other digestion experiments that we could find. The bulletin also discusses the variations in digestion coefficients, and the relation of the digestibility of feed by ruminants to that by poultry. Production coefficients are given for calculating the digestible protein and productive value of poultry feeds. A table is given showing the average composition and productive value of poultry feeds and a method is described for calculating the composition and feeding value of mixed feeds for poultry.

Sulphur

The intensive study of sulphur as a fertilizer was discontinued as planned at the end of December, but analyses of rain-water and other work have been continued. This work is being prepared for publication in a bulletin, but publication will probably be delayed until some of the details are worked out. It is planned to continue the analyses of rain-water until about March, 1928.

Vitamin Work

The study of the vitamin content of feeds has been continued, most attention being given to method of estimating the vitamin content of foods and to the vitamin content of corn and its products.

About 60 samples of corn were secured from Substations of the Texas Agricultural Experiment Station in various parts of the State. Chemical analyses of these samples brought out the fact that there is a decided variation in the protein content of corn grown in different sections. While the protein content at one of the eastern substations would average about 9 per cent, or even a little lower, the protein content at one of the northwest substations was around 12 per cent. This work will be continued.

Salt Water on Rice

A field study was made of the effect of salt water on rice, in 1925, in collaboration with Mr. R. H. Wyche, Superintendent, Texas Substation No. 4, near Beaumont, Texas, and Mr. J. C. Eisentraut, County Agent of Jefferson County. A bulletin discussing these results and giving a rapid method for estimation for salt in water is being prepared. It is difficult to establish a limit on the amount of salt in the water to be used, but it is best to stop pumping when the water contains over 50 grains of salt to the gallon. Water has been used containing 100 grains to the gallon with fair results, especially after August 1.

Feed Analyses

About 2,000 samples have been examined for the Feed Control Service. The examination includes not only the complete feed analysis of each sample but also a microscopic examination.

A very important part of this work is the establishment of correct names for feeding stuffs and ingredients of mixed feeds, as well as of mixed feeds themselves, so that the purchaser can be correctly informed of the nature of the goods he is buying. Constant efforts are being made to put out goods under names better than they are really entitled to. A number of definitions and standards have been adopted in the past years, but problems are constantly being brought up by the Feed Control Service requesting the cooperation of this Division. One of the present important problems is the correct labeling of mixed feeds and their ingredients.

Fertilizer Control

Inspection and analyses of fertilizers sold under the fertilizer law have been made as usual under the direction of the State Chemist. The number of different analyses offered for sale has been reduced by cooperation between the manufacturers to about twenty, and this has given very favorable results, to the farmer, to the manufacturer, and to the investigator who is called on to recommend fertilizers. The fertilizer bulletin for 1926-27, besides the report of the analyses made under the law, contains a statement of the number of tons sold of each kind of fertilizer. Suggestions as to how to use fertilizer in different parts of the State are also given and also statistics giving the pounds of fertilizer used to the acre in some of the counties using fertilizer, and the approximate percentage of the acreage fertilized.

Bulletin No. 350, "Fertilizer Statistics for Texas," was also published during the year, containing fertilizer statistics of various kinds from 1914 to 1926.

Root Rot Investigations

In the spring of 1927 an emergency appropriation was made for root rot investigations, and this appropriation carried a provision for a chemist. Mr. E. C. Carlyle, of this Division, was assigned to this work, in cooperation with members of other Divisions working on this

project. This work has been largely on samples of soil sent in by the Plant Pathologist or other workers on this project from different parts of the State, to ascertain whether or not there is any relation between pH and root rot. Methods of analysis, and the effect of acid and sulphur on soils, are also being studied in this connection.

Miscellaneous

Analyses were made of a number of miscellaneous samples of soils, irrigation waters, and other materials. Samples of feeds, grass, soils, and other materials were analyzed for the Divisions of the Experiment Station.

The Chief of the Division is Referee on Fertilizers and a member of the Committee of Definitions of Terms and Interpretations of Results on Fertilizers of the Association of Official Agricultural Chemists.

The Division continues to receive requests for analyses of various kinds for private purposes. Information and assistance are always given as far as possible; however, samples are not accepted for analyses unless the information secured is of public interest or would have direct application along the lines of authorized projects. This Division can not accept miscellaneous samples for analyses, for the reason that to do so would interfere with the regular duties assigned to the Division.

HORTICULTURE

Projects

1. Figs; State funds; W. B. Lanham, leader.
2. Pecans; State funds; W. B. Lanham, leader, assisted by Superintendents of various Substations.
3. The Effect of Certain Cultural Methods Upon the Production of Early Tomatoes; State funds; W. B. Lanham and W. H. Friend, leaders.
4. The Effect of Certain Cultural Methods Upon the Yield of Marketable Onions; State and local funds; W. B. Lanham and W. H. Friend, leaders.
5. Pepper Investigations; State and local funds; W. B. Lanham and W. H. Friend, leaders.
6. Tomato Variety Tests; State and local funds; W. B. Lanham and W. H. Friend, leaders.
7. A Cultural and Variety Test of Celery; State and local funds; W. B. Lanham and W. H. Friend, leaders.
8. Cantaloupe Culture; State and local funds; W. B. Lanham and W. H. Friend, leaders.
9. A Study of Miscellaneous Vegetables; State and local funds; W. B. Lanham and W. H. Friend, leaders.
10. Strawberry Production; State and local funds; W. B. Lanham and W. H. Friend, leaders.

11. Pomelo (Grapefruit) Production; State and local funds; W. B. Lanham and W. H. Friend, leaders.

12. Peach Production; State and local funds; W. B. Lanham and W. S. Hotchkiss, leaders.

13. Introduction of Horticultural Plants; State and local funds; W. B. Lanham, leader.

Figs

The objects of this project are: to study the fertilizer needs of figs; to study the control of fig rust; to study the harvesting and marketing of figs. In addition to the objects stated, different varieties are being tested out at the Substations at Angleton and Beaumont, and also at the Main Station at College Station.

The Substations at Angleton and Beaumont are located adjacent to the commercial fig section of Texas. The Magnolia is the variety grown almost exclusively for canning and preserving. The Adriatic, Kadota, and Brunswick yield, perhaps, a little heavier than the Magnolia, but apparently do not make as good preserve products. At College Station the Magnolia, Brunswick, and Ramsey are promising varieties, although the Ramsey cracks badly. The Magnolia at College Station this year made a smaller growth than any other variety, but yielded the heaviest. No record of yield was made, as the severe infestation of the cotton worm moth prevented proper maturing of the fruit. The best flavored fresh figs grown at College Station are the Mission and the White Adriatic; however, the yields were small.

Fertilizer experiments with figs have been conducted at Beaumont and Angleton for the past three years. Owing to a misinterpretation of the project, the results at Beaumont are valueless. The results at Angleton indicate that the highest yield was obtained from lime alone, and the next highest yield from a complete fertilizer. There was very little difference in the total yield from these two plats. In all cases where phosphoric acid was used, a slight increase in yield was noted. No appreciable results were obtained from either potash or nitrogen. In all cases where sulphur was used the growth was retarded, and sulphur at the rate of 750 to 1000 pounds to the acre killed the trees.

At Beaumont and Angleton the fertilizer experiment has been revised so as to allow comparison between lime alone, lime with a complete fertilizer, and a complete fertilizer alone. At Angleton a block of 100 trees in the center of a commercial orchard has been secured, and lime at the rate of approximately one ton to the acre has been applied to every alternate row. It is hoped that five repetitions of lime will give conclusive results. At College Station a fertilizer experiment to test the effect of potash on figs has been started. The following four formulas are being used at the rate of 400 pounds to the acre: 8-4-0; 8-4-4; 8-4-6; 8-4-8. Up to date no difference in growth has been noted.

Texas Station Circular No. 47, "Spraying for the Control of Fig Rust," was received from the printer on July 15, 1927. This circular

gives results of spraying experiments with figs at Angleton and Beaumont. The following summary is given:

There was practically no difference in the effectiveness of Bordeaux 5-5-50 and Bordeaux 10-10-50 in the control of rust.

Bordeaux used as a dormant spray had no effect in controlling rust.

Bordeaux applied to leaves appeared to protect all treated leaves throughout the season. There was little difference in results in spraying at intervals of fifteen, thirty, or forty-five days.

These results indicate that fig trees should be sprayed with Bordeaux 5-5-50 as soon as the disease appears, which is usually about July 15. Subsequent applications should be made often enough to protect new leaves and fruit until the last fruit is mature, probably on the average of every thirty days after July 15 until at least September 15.

The common practice of fig growers is to prune figs very heavily, leaving about four to seven shoots or branches and then cutting these back, leaving about four nodes of last year's growth. No experiment has been conducted in Texas to determine the best method of pruning figs. A series of experiments was, therefore, started this year at Angleton and Beaumont, in which certain trees were pruned more severely than the common practice, some according to common practice, and some at varying degrees lighter than the common practice. Much interest is being manifested on the part of fig growers in the experiments being conducted at both Angleton and Beaumont.

Pecans

The object of the work with pecans is to study all of the factors affecting their production. Only one phase of the work was carried during the year, that of pecan propagation, owing to lack of facilities at College Station and at the Substations for other phases of the work. The seedlings at Substation No. 16, Iowa Park, are not large enough for propagation, but there is considerable seedling pecan stock grown at College Station which will be large enough to work with during the next year.

Much interest in pecan work is being shown by pecan growers of the State. At the annual meeting of the Texas Pecan Growers Association a committee of its members was appointed to work toward securing appropriations for a pecan experiment station and for more assistance for the pecan work being done by this Division. Pecan culture is one of the most pressing horticultural problems in the State and it deserves considerable attention.

Tomatoes

In the tomato-growing sections, particularly the Lower Rio Grande Valley and East Texas, there is a common impression among some of the growers and most of the buyers that potash fertilizer will increase the carrying quality of tomatoes. With the object of ascertaining the effect of potash on the carrying quality of tomatoes, fertilizers containing no potash and fertilizers containing varying amounts of potash

were applied to tomatoes at the Substations at Troup, Weslaco, Iowa Park, and the Main Station, College Station. Texas Station Bulletin No. 357, "Effect of Potash Fertilizers on the Carrying Quality of Tomatoes," was received from the printer on July 2, 1927.

Tomatoes grown at Substations were shipped to College Station and, along with the tomatoes grown at College Station, tested to determine the amount of shaking necessary to crack them, the amount of pressure necessary to break them, and the number of times dropped from the given height necessary to crack them. They were also held in storage and a record was kept of the time it took them to ripen and also to decay.

On the light sandy soil at Troup and at College Station, potash in the fertilizer increased the yield of tomatoes this year (1926). The best results were obtained from 8-4-6 mixture. On the rich virgin soil at Weslaco no differences in yield were obtained from the use of any fertilizer. A summary of this year's results from all the stations indicates that there was no consistent difference in the carrying quality of tomatoes that can be attributed to the use of potash in the fertilizer. One year's results indicate that the carrying quality of tomatoes is influenced by three things: namely, the variety; the time of harvesting; the way in which the fruit is handled. Tomatoes harvested early in the season carried much better than fruit picked later in the season from the same plat and apparently at the same degree of ripeness. Tomatoes that had been cracked by dropping were placed in storage with uninjured tomatoes from the same plat. At the end of two days, as high as 25 per cent of the cracked tomatoes had begun to decay. By the end of six days, 50 to 75 per cent of the cracked tomatoes were showing decay, while all of the uninjured tomatoes were in perfect condition.

Two varieties, the New Stone and the Gulf State Market, were used at College Station; the Beauty and the Detroit were used at Troup; and the Livingston Globe was used at Weslaco.

These experiments to test the effect of potash on the carrying quality of tomatoes are being repeated at the same four places. Only one variety, the Livingston Globe, is being used at all places, and the seed was obtained from the same package.

Pomelos (Grapefruit)

The object of this project is to study all phases of pomelo (Grapefruit) production. The freeze of 1925 destroyed a large portion of the fruit on the bearing pomelo grove at Substation No. 15, Weslaco. Some of the trees were broken by ice, but apparently recovered. The fruit, however, especially early in the season, was much smaller than was usually the case. This was probably due to the fact that the trees were weakened from the freeze. The soil management schedule has been reworked and it is believed that it will more nearly solve the pressing problems than the old one. This year the heaviest yield and the largest fruits were obtained from plats that had received no cultivation. This is probably due to the fact that the land absorbed irrigation water more

readily, because 50 per cent more water was required to irrigate these plats than to irrigate the clean cultivated plats. Owing to lack of funds, it was necessary to delay the pruning experiments until so late in the season that no results were obtained this year. A large number of new varieties of citrus fruits have been planted, but are not yet bearing.

Peach Production

The object of this project is to study all problems concerning peach production in the State. At Substation No. 2, Troup, three acres of peaches were planted in the spring of 1922. A fertilizer experiment is being conducted, and last spring a pruning experiment was started. A hail storm in the summer of 1926 not only destroyed the crop of fruit, but severely injured the trees. No results were obtained from either pruning or the fertilizer experiments. It is doubtful that the orchard can be rejuvenated sufficiently for experimental purposes with either pruning or fertilizers.

San Jose scale is again becoming very destructive in East Texas. The experimental orchard at Troup is very heavily infested with San Jose scale, and a series of experiments was started this year with as many oil sprays as could be obtained, with the purpose of comparing their efficiency with commercial lime-sulphur. These results have not as yet been tabulated.

The variety peach orchard planted in the spring of 1924 at College Station made a good growth. A few of the peaches fruited last year, but not enough to furnish a basis for conclusions. The winter this year at College Station was very mild, and there was practically no dormant period. A few of the trees have died and the others are not making as healthy growth as they made last year. Owing probably to the fact that the trees have failed to go through a normal resting period, not much fruit has set.

The pruning experiment was started on this orchard last year. One tree of each variety was pruned very severely, one moderately, and one only thinned lightly, with no heading back. A record was made of the diameter of the trunk, and the height and breadth of the tree were measured both before and after pruning. Height and breadth measurements were taken this spring, and a summary of results indicated that the method of pruning, on the average, has nothing to do with the height, breadth, and diameter of the tree at the end of the second year of growth. In other words, the trees, on the average, were of the same height and breadth and had the same trunk diameter, regardless of the method of pruning. These are results of only one year's work, at one place, and for very young trees.

Introduction of Horticultural Plants

The work under this project was continued during the year, which has for its object the test of horticultural plants obtainable from any source,

for adaptability to Texas conditions and to find the best methods of propagating such plants for general use. At College Station, in addition to the peach variety orchard mentioned under "Peach Production," a varietal orchard of one hundred plums and ninety-seven grapes was planted in the spring of 1926. Also a number of varieties of figs were planted. Such plants offered by the Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, as seemed promising for this territory have been planted. A few peaches fruited, but none were superior to common varieties. The two most promising comparatively new ornamentals are Athel (*Tamarax articulata*) and Chinese elm (*Ulmus pumila*). The Chinese elm, however, is very susceptible to root rot (*Phymatotrichum omnivorum*). A number of ornamentals secured from local nurserymen have also been planted.

According to observations made on the fruits in the old orchard on the Main Station Farm, the following seem worthy of propagation: Methley plum, Crosby nectarine, and Quetter nectarine. A limited amount of propagation material from these varieties has been furnished to interested nurserymen. Seedlings were budded with these varieties at College Station, but owing to the long dry spell directly after budding, few grew. In spite of the mild winter, jujubes are fruiting heavily this season, and a study is now being made of the different varieties.

Considerable interest is being manifested in Southwest Texas in the culture of dates. The principal handicap to date culture in Texas has been the inability to secure a variety that would either ripen before the fall rains or would withstand some rain during the ripening period. The Deglet Noor, the variety grown in California and Arizona, will not withstand rain during ripening. There are a number of seedling dates growing in the Lower Rio Grande Valley and also in the Winter Garden district. Some of these produced good fruit, but for commercial use the varieties will have to be standardized. The Agricultural Experiment Station has not encouraged the importation of date offshoots into the State, as there is danger of importing date pests. The United States Department of Agriculture supplied free of charge ten offshoots of different varieties for planting on the Substation at Weslaco. These offshoots were cooked so as to kill the pests. Seven of them survived, which, according to Dr. Swingle, is a very good record. Twenty additional cooked offshoots of two standard varieties were purchased and an additional quantity of rare varieties were furnished by the Office of Foreign Seed and Plant Introduction, from the Date Experiment Station, Indio, California. These offshoots have all been planted at Weslaco.

Horticultural plants are being tested out at practically all of the fifteen substations, special attention being given to this work at the Substations at Troup, Angleton, Beeville, Beaumont, Nacogdoches, Balmorhea, and Iowa Park. The Myers lemon, planted early in the spring of 1924 at Beaumont, fruited heavily last season. The fruit was very large, resembling an orange more than a lemon. The citric acid con-

tent was found to be high, however. Probably if the fruit were picked as other lemons are picked with reference to size only, they would make a commercial lemon. This lemon has not as yet fruited in the Rio Grande Valley.

RANGE ANIMAL HUSBANDRY

Projects

1. Sheep Breeding Investigations (study of the Inheritance of Fur Qualities of Karakul Sheep); State and Federal funds; J. M. Jones and J. L. Lush, leaders.

2. A Determination of the Relation of Skin Folds to Weight of Fleece on Rambouillet Sheep; State and local funds; J. M. Jones, J. L. Lush, and E. W. Thomas, leaders.

3. A Study of Type and Inheritance in Angora Goats; State and local funds; J. M. Jones, J. L. Lush, and E. W. Thomas, leaders.

4. Inheritance of the Ridgling Characteristic in Goats; State and local funds; J. L. Lush and E. W. Thomas, leaders.

5. Inheritance in Brahma and Hereford Cattle; Adams, State and local funds; J. L. Lush, leader.

6. Fattening Steers on Sumac Silage, Sumac Fodder and Cottonseed Hull Rations, Supplemented with Ground Milo Heads and Cottonseed Meal; in cooperation with Bureaus of Animal Industry and Plant Industry; E. W. Sheets (B. A. I.), F. D. Keating (B. P. I.), and J. M. Jones, for Station.

7. Feeding and Killing Qualities of Brahma, Shorthorn, Hereford, Brahma-Shorthorn, and Brahma-Hereford Calves; in cooperation with the Bureau of Animal Industry, United States Department of Agriculture, and the King Ranch; State and cooperative funds; W. H. Black, for Bureau of Animal Industry, and J. L. Lush, for Station.

8. The Relation of Body Shape to Rate of Gain, to Dressing Per Cent, and to Value of the Dressed Meat in Beef Cattle; Purnell fund; J. L. Lush, leader.

9. Insects and Parasites Affecting Livestock; in cooperation with the Bureau of Entomology, U. S. Department of Agriculture; State and cooperative funds; F. C. Bishop and O. G. Babcock, for Bureau of Entomology, and J. M. Jones and W. L. Black, for Station.

10. A Study of the Adaptation of the Corriedale Sheep to Southwest Texas Conditions; in cooperation with the Bureau of Animal Industry, U. S. Department of Agriculture; State and cooperative funds; J. M. Jones and E. W. Thomas, leaders.

11. An Economic Study of Shearing Sheep Once Versus Twice a Year; State and local funds; J. M. Jones, leader.

12. Determining Grades and Shrinkages of Representative Samples of Texas Wool and Mohair; State and local funds; J. M. Jones and W. H. Dameron, leaders.

13. Relation of Age of Animal to Fineness of Wool and Mohair Fiber; Purnell fund; J. M. Jones and J. L. Lush, leaders.

14. Methods of Preparing Sorghum Roughages and Grains for Feeding to Fattening Calves and Lambs; State and local funds; J. L. Lush and R. E. Dickson, leaders.

15. Studies in the Growth of Mohair; in cooperation with the Bureau of Animal Industry, U. S. Department of Agriculture, and the Department of Animal Husbandry, A. and M. College of Texas; State and cooperative funds; leaders: A. K. Mackey (for the College), D. A. Spencer and J. I. Hardy (for Bureau of Animal Industry) and J. M. Jones (for Station).

Sheep Breeding Investigations

All detail data on this project, except the descriptions of the skins, are taken at Substation No. 7, Spur. Breeding work is being directed toward a moderate degree of close breeding, with the object of determining whether by thus reducing the genetic variability in the flock a more uniform group of pelts can be produced. Commercially, Karakul sheep have not been a success on the Experiment Station. This is due to the fact that it is quite difficult to sell small lots of skins, as they are not uniform in appearance. Even large lots of skins do not command a very high price, due to competition with skins produced at low cost in Asia. The Karakul sheep, however, have been hardy and prolific and the lambs born dead have a salvage value not possessed by other breeds. This should make them economically desirable in some regions where climatic conditions are so unfavorable that other sheep do not thrive well.

Relation of Skin Folds to Weight of Fleece in Rambouillet Sheep

This study has been systematically under way since 1922. The registered Rambouillet ewe flock has now been increased to approximately 170 head. The flock is being improved through the use of B and C type stud rams, and although the data which have been taken in connection with this study since its inception have not been completely analyzed, we are now able to state that the investigation has proceeded sufficiently far to justify a thorough analysis of the data which have been gathered. Wool grading and scouring tests are being continued, in addition to regular weight records and some fifteen body measurement records.

This year's wool records have tended to substantiate our previous tentative conclusion that B and C type Rambouillet ewes produce approximately the same amount of clean or scoured wool during 12 months' growth. In 1925-26, as reported in the past year's report, 90 head of C type registered Rambouillet ewes produced an average of 3.6 pounds of scoured or clean wool as compared with a clean yield of 3.42 pounds produced by 37 B type ewes. During the year 1926-27, 87 C type Rambouillet ewes produced 3.34 pounds of wool, clean content basis, as compared with 3.41 pounds produced by 37 B type ewes, or a difference of .07 of a pound per head in favor of the B type ewes. On the other hand, the C type ewes produced a staple averaging 2.47 inches in length as compared with 2.22 inches produced by the B type ewes.

Wool diameter measurements are being continued on all of the registered Rambouillet ewes and stud rams. The diameter measurement work is being continued throughout the period of usefulness of Rambouillet ewes for the purpose of determining the relation of age to the size of wool fibers produced, from the first shearing until the animal has served its period of usefulness in the flock.

Type and Inheritance in Angora Goats

This study was initiated with the view of ascertaining something more definite regarding type and inheritance in Angora goats. Considerable energy has been expended during the several years that this project has been under way in an effort to develop a real representative stud flock of Angora goats. Some outstanding progeny have resulted, which drew some very favorable comments from a number of Texas' most progressive Angora goat breeders at the Third Annual Ranchmen's Roundup held at the Ranch Experiment Station, August 9 and 10. This study is being pursued along very similar lines to the project on "Relation of Skin Folds to Weight of Fleece in Rambouillet Sheep." Accurate fleece weights and the respective grades, including shrinkages and clean yields, are being recorded. Some fifteen additional records, including weights of goats at various seasons of the year and a number of body measurements, are being recorded annually. Diameter measurements by means of the micrometer caliper are being made. A number of these records have been incomplete, owing to the necessity of culling a large number of the goats of the least desirable type. This experiment has now progressed sufficiently far to warrant a complete analysis of all data.

Inheritance in Brahma and Hereford Cattle

Intensive study of the body measurement records taken in this project has been carried out and nearly all of the routine statistical work has been brought up to date. The interpretation of these results will be one of the main objects of the work during the coming year. Changes in body shape during intensive fattening in feed lots are primarily increases in width and circumference of the body. There is very little increase in depth of body and practically none in height or body length, except such as would normally occur in the frame growth of cattle of that age even if not fed a fattening ration. Increases during fattening period were more pronounced in chest width, loin width, and chest circumference than in the other measurements studied. Increases were least in head measurements, height over withers, body length, and chest depth. Ratios between height at withers or body length or chest depth (as measures of the growth of the fat-free live animal) and chest width or loin width or chest circumference (as measures of the parts of the body where much fat is deposited), should give good objective measures of the changes in fatness of cattle in experiments where it is impossible to determine the fatness of the cattle directly by slaughter and chemical analysis.

Breed differences shown by body measurements have been surprisingly slight when tested by adequate statistical methods, except in the case of a few characters which have extremely slight economic importance, such as: amount of dewlap, length of ears, or length of horns. Economically important differences are mostly in the muscles and softer parts of the body, which are difficult to measure accurately with tape and yardstick.

The sixth crop of first-cross steers and the third crop of back-cross steers were fattened at the Spur Station this winter and were marketed in Fort Worth, at an average age of about fourteen months. A large amount of slaughter data was secured on these cattle and, while not analyzed completely, seems to agree fairly closely with previous data. Brahman cattle have higher dressing percentages than Hereford cattle, but their carcasses are of less desirable conformation in the eyes of the average butcher. The discrimination against the Brahman conformation increased with the age and size of the carcass, there being practically no discrimination against calves or carcasses weighing 300 to 450 pounds. With increasing age and weight the discrimination against the Brahman conformation increases, becoming quite marked on three- and four-year-old steers. Very little progress has been made in studying the actual quality, tenderness, palatability, and other intrinsic characteristics of the meat, because objective standards for measuring those characteristics are not yet developed completely. It is hoped that the nation-wide cooperative study of factors which influence the quality and palatability of meat may provide such standards in the near future.

The seventh crop of first-cross calves and the fourth crop of back-cross calves were dropped at Substation No. 14, Sonora, this year and will probably be carried on pasture there another year before the steers are to be fed out.

Inheritance of the Ridgling Character in Angora Goats

This year's work has confirmed the work of the last two years in showing that cryptorchidism in goats is a hereditary characteristic. In the 1927 kid crop 21 of the 67 grade buck kids (all sired by ridgling bucks) were ridglings, while only 5 of the 67 purebred buck kids (none of which had ridglings for direct ancestors) were ridglings. In the eleven years up to and including 1927, 6.1 per cent of the 890 male kids having no ridglings for direct ancestors have been ridglings, while 23.2 per cent of the 311 male kids sired by ridglings have been ridglings. Many of these 311 male kids have been out of dams sired by ridglings. The evidence seems to show clearly that this defect is hereditary and, therefore, that ridgling bucks should not be used as sires under any circumstances. However, it is not yet clear whether inheritance is Mendelian or, if so, how many factors are concerned. Future efforts are to be directed toward solving this problem so that we may know how to cull the doe flock in order to eradicate the defect more rapidly from purebred flocks. Cryptorchidism occurs among all domestic animals,

but is more frequent in goats than in any other domestic animal. Present indications are that more than one pair of Mendelian factors are concerned, but that the number is not extremely large. One ridgling buck has in three years sired 28 ridglings among 78 sons, while another ridgling mated to does of similar breeding has consistently sired a smaller proportion—19 ridglings among 65 sons.

Feeding and Killing Qualities of Calves

This is a cooperative project with the United States Department of Agriculture and with the King Ranch. The past year was the third year of the experiment and during the year nearly one hundred head of calves were fed out at Kingsville and detailed records were secured of the feedlot data and of all slaughter data which from the previous two years' work seemed likely to yield any valuable information. During this year a grading committee appointed by those in charge of the cooperative projects on the study of meat graded the thin steers, the fat steers, and the dressed carcasses. The data from this grading have as yet not been analyzed. In general, the results of the third year's work tend to substantiate the first two. During this year the project included a comparative test of Rhodes grass hay and hegari stover as roughages for fattening steers.

The Relation of Body Shape to Rate of Gain, to Dressing Per Cent and to Value of the Dressed Meat in Beef Cattle

Records bearing on this problem have been accumulated for nineteen lots of steers fed out at Substation No. 7, Spur, during the last five years, and analysis of those records has proceeded rapidly during the year. All averages, deviations, and primary correlations have already been calculated, and the interpretation of those figures by means of path coefficients and otherwise should be well advanced during the coming year. A detailed study of about ten thousand cattle weights showed that under constant weather and other environmental conditions the probable error of single weight of a given steer was about four to six pounds. The probable error of a three-day average weight is only about 58 per cent as large or, roughly, two to three and one-half pounds. These large variations in the daily weights of the same animal are due chiefly to variations in the amount of feed and water contained in the digestive tract from time to time.

Method of Preparing Sorghum Roughage and Grains for Feeding to Fattening Lambs and Calves

This test was started during the fiscal year 1926-27, with the object of determining (1) the effects of chopping or shredding sweet sorghum roughages and the grain sorghum roughages for fattening lambs and cattle, and (2) the effect of grinding the grain sorghum heads, rather than to feed them whole or unground.

The results of the 1926-27 lamb-feeding test, unfortunately, do not justify any conclusions with reference to the relative methods of preparing the various sorghum roughages for fattening lambs, due primarily to the fact that the winter rains rendered the roughages practically unfit for utilization. The results do point strongly to the conclusion that lamb feeders should by all means avoid feeding soured and mouldy roughage to fattening lambs.

Steer Feeding: Three lots of ten steers each were fattened for 110 days. All three lots received milo heads, cottonseed meal, and sorghum fodder, and made fairly good gains. In one lot the heads were not ground and in another lot the sorghum bundles were run through an ensilage cutter and chopped up into pieces about half an inch long. The results are to be considered as tentative, since this was the first year of work and especially since 110 days is a rather short fattening period for cattle. However, the data seem to indicate that the ground heads were considerably more valuable than the unground heads. The lot receiving whole heads made about 14 per cent lower gains and had a lower dressing per cent and a smaller fat yield than the other two lots. Chopping the cane did not seem to be of any advantage, as the two lots which both received ground heads made practically the same gain and differed very little in dressing per cent or fat yield. Consumption of roughage was only seven per cent greater in the lot receiving the sorghum bundles. Tentatively, the results are interpreted to mean that sorghum grains or heads should be ground for best results with fattening cattle, but that grinding or chopping the roughage has little effect. More experiments, especially with longer feeding periods, will be required to confirm or disprove conclusively this tentative interpretation.

Fattening Steers on Sumac Silage, Sumac Fodder and Cottonseed Hull Rations, Supplemented with Ground Milo Heads and Cottonseed Meal

This project has been carried in cooperation with the United States Department of Agriculture during the years 1923-24, 1924-25, and 1925-26, at the United States Experiment Station at Big Spring, Texas, the experiments being conducted with three different groups of calves. The results of this experiment have been published in Texas Agricultural Experiment Station Bulletin No. 363, "Sorgo Silage, Sorgo Fodder and Cottonseed Hulls as Roughages in Rations for Fattening Calves," and the project has been discontinued. The data have also been published as United States Department of Agriculture, Technical Bulletin No. 43.

This experiment shows conclusively that sorgo silage and fodder are more satisfactory roughages than cottonseed hulls when fed along with ground milo heads and cottonseed meal to fattening calves.

Insects and Parasites Affecting Livestock

This project, which is carried in cooperation with the United States Department of Agriculture, Bureau of Entomology, is divided into three parts, as follows:

Subproject No. 118-A, The Screw Worm and the Wool Maggot.

Subproject 118-B, The Goat Louse.

Subproject 118-C, A Study of the Sheep Scab, the Sheep Scab Mite, Its Life History and Eradication.

The Screw Worm and the Wool Maggot: The complete report for the year on this phase of the project is not available at this time, and no report is made herewith.

The Goat Louse: This subproject, which was approved in 1920, remained quite inactive until 1925, during which year the Angora goats used in this study were placed under complete control for the first time. The three species of goat lice under observation in this study are: *Trichodectes climax, Linognathus stenopsis,* and *Trichodectes hermsei.* Various chemicals and dipping preparations, including some well known proprietary ones, are being thoroughly tested out under controlled conditions. Satisfactory progress has been made in the goat lice control work during the past year and it is the plan of those in active charge of the project to issue a preliminary report upon the findings during the forthcoming fiscal year.

A Study of the Sheep Scab, the Sheep Scab Mite, Its Life History and Eradication: A considerable portion of time has been spent during the past year in an effort to ascertain something more definite with reference to the period that the scab mite will remain alive off the host. In this phase of the study clean sheep were introduced into a pen immediately upon removal of scab-infested sheep. These sheep were observed upon different occasions lying upon fleeces from scab-infested sheep. In this particular test scab did not develop within the period, May 20, 1926, to January 3, 1927. Similar trials were carried out on other lots, the clean sheep being placed in the lots from which infested animals had been removed at 7, 15, 21, 31, and 54-day intervals. In all instances, fleeces which had been removed from scabby sheep in the respective intervals were placed in these lots and upon occasions the sheep were seen lying on these fleeces at one time or another. In this particular series of tests between May 20, 1926, and January 3, 1927, scab did not develop after clean sheep were placed in pens from which scabby sheep had been removed. This work is being checked; however, the report covering the activities since January 1, 1927, has not been received.

During the summer of 1926, some 30 tests were conducted in an effort to determine the longevity of scab mites off the host. In most cases the adult mites were placed in a pill box, which was in turn placed within a small tin box. In some instances the containers were buried from one to two inches in the ground. In other instances the box re-

mained exposed to the sunlight or was placed in a liveoak thicket in the shade. Accurate temperature records were kept, including the temperature of the soil both at the surface and at the depth at which the mites were buried. Detailed reports of the activities of the scab mites under various conditions were kept. The maximum period that the mites remained alive under conditions tested was approximately 16 days. Mites live but a very short time when exposed to the rays of the sun.

A series of dipping tests was continued during the year for the purpose of testing the efficiency of the various preparations in the control or complete eradication of the scab mite. Among the dips tested were nicotine sulphate, which was used at a strength of .065; temperature of bath, 102.2 degrees F; time sheep were held in vat, three minutes. A series of lots of scabby sheep were dipped twice at intervals of 7, 9, 11, 13, 15, and 17 days. All of these different methods seemed to be effective, since all cases of scab were completely cured up with the two dippings. Cooper's Arsenical Cattle Dip was also used at strengths of .14, .18, and .225. There yet remains further work to be done with reference to this proprietary preparation. A number of other preparations have been tested or are being tested at the present time. It is hoped that the data so far collected in connection with this sheep scab project may be available for publication in the form of a progress report during the next fiscal year.

A Study of the Adaptation of the Corriedale Sheep to Southwest Texas Conditions

This project, which is carried in cooperation with the Bureau of Animal Industry, United States Department of Agriculture, was begun in 1920, with only 8 head of registered Corriedale ewes and a registered Corriedale ram, shipped from the sheep ranch of the United States Department of Agriculture, at Dubois, Idaho. The object of this experiment is to determine the relative adaptability of registered Rambouillet and Corriedale sheep to the conditions of Southwest Texas in the Edwards Plateau region. Data recorded in connection with this project have included birth weights, breeding and weaning weights, fleece weights, grade, length and clean weight of wool, and notes on the general thrift of the two breeds of sheep. The increase in the number of Corriedale ewes has been slow, the total number of aged and yearling ewes having reached only 35 head in the spring of 1927. According to data secured in connection with this experiment, the aged Rambouillet ewes outweighed the corresponding class of Corriedale ewes by approximately 14 pounds per head both in the fall of 1926 and in the spring of 1927. The average birth weight of 17 Corriedale ram lambs born in the spring of 1927 was 10.28 pounds as compared with an average birth weight of 10.62 pounds for 56 head of Rambouillet ram lambs. Four Corriedale ewe lambs born in the spring of 1927 averaged 10.08 pounds as compared with an average birth weight of 9.9 pounds for 51 head of Rambouillet ewe lambs. The lambing percentage for 31 Corriedale

ewes was 74 per cent as compared with a 65 per cent lambing record for 143 registered Rambouillet ewes. One hundred and twenty-eight aged Rambouillet ewes produced an average of 3.36 pounds of wool, clean yield, as compared with 3.36 for 29 aged Corriedale ewes in the spring of 1927 at 12 months' growth.

Shearing Sheep Once Versus Twice a Year

This study, the object of which is to determine the comparative production of wool from sheep sheared once and sheep sheared twice a year, has been under way since the fall of 1920. Results in this study over the seven-year period show that there is an advantage of 0.75 pound grease weight of wool per head in shearing twice a year. These records covered 1079 individual animals shorn in the 12-months fleece group and 1110 in the 6-months or twice a year group. The reversal method was used during the first five years of the experiment, during which period there did not seem to be much difference in the total grease wool production of the two groups. In 1925 it was decided to discontinue the reversal method upon the suggestion that a group sheared twice a year over a period of years would produce an increased amount of wool. In the 1925-26 shearing test the group of aged ewes (including ewes ranging from 2 to 6 years of age) produced 1 pound more wool (grease weight) per head in the 12-months period than did the corresponding group sheared once a year. During the same year, a group of yearling ewes sheared twice a year produced .75 pound more wool (grease weight) per head than the corresponding group of yearlings producing 12-months fleeces. During the year 1926-27, the difference between the two groups of aged ewes had increased to 1.44 pounds (grease weight) per head in favor of those sheared at 6-months intervals, while in the yearling group the difference increased to 1.38 pounds per fleece (grease weight) in favor of those sheared twice a year. This difference in grease fleece weight does not appear to be significant in view of the fact that on the basis of the current market quotations for Texas wools, staple or combing wool is worth from 5 to 10 cents more per grease pound than are fleeces sheared at 6-months intervals.

Scouring tests on representative samples of wool from Rambouillet ewes in this project were made both from the group sheared twice a year and those sheared at 12-months intervals. Four hundred and twenty-nine pounds of fall-sheared wool (1926) shrank 56.6 per cent; 672.48 pounds of spring (1927) sheared wool from the same ewes in the fall of 1926 shrank 56.1 per cent, as compared with a shrinkage of 54.7 per cent on a 189-pound sample from 25 Rambouillet ewes carrying 12-months fleeces in the spring of 1927.

This test will be continued through the next fiscal year, when it is hoped that sufficient data will have been accumulated to publish the results as an Experiment Station Bulletin and complete the project. This is a local problem, and the sheep raisers of West Texas have been

kept informed upon the progress made from year to year through the columns of the Sheep and Goat Raisers' Magazine.

Determining Grades and Shrinkages of Texas Wool and Mohair

This project has for its primary object the accumulation of a sufficient amount of data which would give the wool and mohair growers of Texas a more accurate knowledge of the grades and shrinkages of the wool and mohair they are producing.

In addition to the number of individual fleeces of wool and mohair from sheep and goats from Substation No. 14, Sonora, which are used in this project, we endeavor to get representative samples from ranchmen in the different parts of the State each year. This is necessary on account of the wide variation in climatic and soil conditions over such a vast amount of territory. Each year it has been the custom of the man in charge of the wool and mohair scouring plant to make a trip into Southwest Texas, which is the center of sheep and goat production for the State, to visit patrons of the scouring plant and to discuss scouring and grading reports with them. Also, the trip gives the wool and mohair specialist occasion to explain the purpose of the scouring plant to men who have not already been acquainted with it. In addition to this, the wool and mohair specialist has occasion to find out whether or not the producers of wool and mohair are deriving any benefits from the tests being conducted at the scouring plant. Mr. W. H. Dameron, wool and mohair specialist, accompanied during the first ten days by the Chief of the Division, made a trip of this nature this spring, which began April 11 and ended May 7. A large number of former patrons were visited, as well as several men who had not submitted samples heretofore. The men called former patrons are men who have submitted samples prior to this year. Some of them have sent samples only one year and others have sent in samples every year since the plant has been in operation. As to the value of the work being done by the scouring plant, it is believed that the statements of the men who have submitted samples will prove the value of the plant to Texas sheep and goat men. Their general contentions are:

1. They have learned their grades of wool.
2. They have learned that there is a rather wide variation in shrinkages from year to year.
3. They have acquired some idea as to what their shrinkages will be for a certain kind of year.
4. They have learned approximately what their production of clean wool is per animal.
5. They have learned that shrinkage and grade of wool give them some basis on which to cull their flocks of the light producers.
6. They claim that the wool and mohair scouring plant is responsible for their being able to sell their wool at 5 to 8 per cent less shrinkage than before the plant was established.

Other claims are made, but these are sufficient to show the sentiment

of the patrons of the scouring plant. The statements given above are explained to producers of wool and mohair who are not acquainted with the work of the plant.

During the trip to Southwest Texas this spring, thirty-one ranches were visited where the owners were seen, and five were visited without seeing the owners. Seven wool and mohair storage houses were visited and some study of their methods of selling was made. The acquaintance of a large number of sheep and goat men was made in the different towns in the territory. The flocks on a few farms between College Station and the southwest territory were visited on the trip both going and returning. It is found interesting to compare grades and shrinkages from the farm flock with those from the ranch flocks. The shrinkages on the farm flocks are usually greater, the scoured wool does not have as attractive an appearance, and the wool is somewhat harder to scour. This is to some extent due to the method in which the sheep are handled, those on farms being confined to smaller pastures, having access to cultivated fields, and usually getting more concentrated feed.

Mohair: Mohair producers do not have the problems to confront them in selling their products as do the wool growers. The shrinkage in mohair is a minor item as compared with shrinkage in wool. It is on an average about one-fourth as much. Since there has not been much attention paid to shrinkage and grades by the buyers of mohair in the country, they have not caused the producer to think about the matter except to produce heavier fleeces. The same prices are usually paid to the producer for the light or heavy, coarse or fine fleeces, except in the case of kid hair. To get the real heavy, oily fleeces it appears that many goat breeders may sacrifice too much quality of hair and length of staple. In case a majority of breeders do this, it will not be long before the mills and commission men will buy mohair on a shrinkage and quality basis in the field, as they buy wool at present. These points are being discussed with the growers at all opportunities, and some of the most prominent goat breeders are keeping this in mind and send in samples of mohair to get a check on their grades and shrinkages.

A large number of individual mohair fleeces from the Ranch Experiment Station, Sonora, are scoured each year to give a check on the proper amount of oil for a fleece to carry to maintain its commercial value. This is a comparatively well known fact, but it will take these figures at the termination of the project to make statements more forceful. It is also desired to determine the amount fleeces from the same goat increase in coarseness from year to year. During the year, 49 individual mohair scouring tests were made for patrons of the scouring plant and 446 for Substation No. 14, Sonora. Mohair is easier to scour than wool, but is much harder to dry. This is due to the actions of the fibers as they dry out. Wind will scatter mohair worse than it does feathers; hence the plant dryer cannot be used on it. Mohair has to be spread out in boxes in the sunshine or in the scouring plant for two or three days before it is ready to be weighed. This condition has been partly

overcome this year by the building of and use of wire-bottom boxes which will permit air to pass through the fleeces.

During the year, 743 separate wool scouring tests covering 11,800.01 pounds of grease wool were made. One hundred and eighty-eight of these tests were made for wool producers of the State, while 555 wool scouring tests were made on samples from Substation No. 14, Sonora.

Accurate Methods of Selecting Wool Samples for Scouring: During the past year, methods of selection of representative wool samples for scouring were continued along lines as had been followed during the two previous years. A large number of individual fleeces have been scoured from the sheep at the Ranch Experiment Station, Sonora. In some cases shrinkages have been determined on as many as six fleeces from the same sheep and in many other cases shrinkages are available for five or less fleeces from the same sheep. The flock from which these data came was a flock of high-grade Rambouillet sheep at the Ranch Experiment Station, Sonora, consisting of both B and C types, but with the C type somewhat predominating. The shrinkage figures are taken entirely from ewe fleeces. The entire fleece was scoured and the shrinkage thus obtained was treated as a unit. Five hundred and eighty-seven fleeces, which consisted of wool ordinarily known as six-month's wool, but which in this case had varied from about five to seven months in growth, being, however, the same for each group at each season, are included in this study with additional data upon one hundred twenty-three fleeces of approximately twelve months' growth from sheep of the same flock. The results of these wool-scouring studies have shown that 25 fleeces from sheep impartially selected will have a shrinkage sure to be in practically all cases within two per cent of the true shrinkage of the entire group sampled. In most cases the shrinkage will be closer than that to the true value for the entire flock and, indeed, half of the 25 fleece samples thus scoured will have a shrinkage within two-thirds of one per cent of the true shrinkage for the flock. One hundred fleeces selected in a similar manner will have a shrinkage sure to be at least within one per cent of the true shrinkage of the flock sampled in practically all cases and much closer in most cases. Half of all such 100 fleece samples will have a shrinkage actually within one-third of one per cent of the true value for the entire flock from which the sample was taken.

Relation of Age of Animal to Fineness of Wool and Mohair Fiber

The object of this study is to determine the influence of age of animal upon the fineness of wool and mohair fibers produced. This study has included the measurement of 100 fibers annually from shoulder, side, and thigh samples, respectively, from practically all of the females constituting the registered Rambouillet sheep and Angora goat flocks. It has also included at least one set of fiber diameter measurement records on practically all ram lambs and Angora buck kids produced at the Ranch Experiment Station, while annual measurements have been taken of

samples from rams and ewes and Angora bucks and does retained for stud purposes. Although this project has been under way only since December 30, 1925, considerable fiber diameter measurement work had already been done in connection with Projects No. 141 and 142, inheritance studies in Rambouillet sheep and Angora goats, respectively, since 1923. Sufficient data have now been accumulated in connection with this project to warrant a complete analysis.

Studies in the Growth of Mohair

This project, which is carried in cooperation with the Animal Husbandry Department, Texas A. and M. College, and the United States Department of Agriculture, has for its object the determination of the normal rate of growth and the establishment of the growth curve for mohair as the foundation for "Studies in the Growth of Mohair" as related to various methods of breeding, feeding, and management, and supplements other mohair studies, such as those being made by the United States Department of Agriculture and also the study of "Type and Inheritance in Angora Goats" being conducted under Project No. 142 under way at this Station at the present time. In this study, representative Angora goat fleeces from both the A. and M. College and the Ranch Experiment Station flocks will be submitted to the Sanford Mills, at Sanford, Maine, where they will be graded carefully in the presence of a representative of the Bureau of Animal Industry, United States Department of Agriculture. The rate of growth studies will be made for the present time only on the Animal Husbandry flock of Angora goats at College Station. This project was begun June 24, 1927; consequently, no detailed information is available at this early date.

ENTOMOLOGY

Projects

1. A Study of the Ingestion of Poison by the Cotton Boll Weevil; Adams fund; F. L. Thomas, leader.

2. Life History of the Cotton Hopper (*Psallus seriatus*) (Reut.), and Its Control; State funds; F. L. Thomas and H. J. Reinhard, leaders.

3. Miscellaneous Insect Investigations: Control of Ants on Citrus Trees; State funds; F. L. Thomas and W. H. Friend, leaders.

4. Control of Scale Insects on Citrus; State and local funds; F. L. Thomas, W. H. Friend, and M. McPhail, leaders.

5. Boll Weevil Control by Use of Airplanes; State funds; F. L. Thomas, leader.

6. Sulphur and Sulphur Compounds as Fungicides and Insecticides; cooperative (Freeport Sulphur Company) funds; F. L. Thomas and J. J. Taubenhaus, leaders.

7. Hibernation of the Cotton Flea Hopper and the Boll Weevil; State funds; H. J. Reinhard and M. McPhail, leaders.

8. Insect Pests of Corn and Grain Sorghums While in Storage; State funds; F. L. Thomas and W. L. Owen, Jr., leaders.

9. Foulbrood Inspection; State funds; S. E. McGregor, Jr., leader.

10. Beekeeping Investigations; State funds; F. L. Thomas, leader.

11. Life History and Methods of Controlling the Pecan Twig Girdler (*Oncideres texana*); cooperative (with the School of Agriculture) funds; S. W. Bilsing, leader.

12. Life History and Control of the Pecan Nut Case Bearer (*Acrobasis caryae, Grote*); cooperative (with the School of Agriculture) funds; S. W. Bilsing, leader.

Ingestion of Poison by the Boll Weevil

Data on the determination of the manner in which boll weevils obtain poison were again collected. As a result of experiments which have been carried on this year and previously, it appears that 70 per cent of the weevils killed by calcium arsenate obtain the poison by picking the particles of dust from the surface of the leaves and stems and only 30 per cent are poisoned by the dust as a result of feeding on the squares and bolls. In varieties of cotton grown from pure seed there is a considerable range in the pubescent or hirsute character on different plants. Preliminary tests show that better control is obtained on plants having more pubescence than on plants which lack this character, because of the ability of the former to retain the particles of dust.

The Cotton Hopper and Its Control

Because of the widespread alarm as a result of the early and extensive injury produced by the cotton flea hopper in 1926, an emergency appropriation was granted by the Legislature for use during the season of 1927. Plans were made for investigating control measures at five different locations in the State, in addition to doing early preliminary work in the Lower Rio Grande Valley. The locations selected for these investigations were in large cotton-producing sections and in places where flea-hopper injury has been severe and more or less recurrent from year to year. Field headquarters were established at the following points: Robstown, in Nueces County; Taylor, in Williamson County; McKinney, in Collin County; and Paris, in Lamar County. The men at the Robstown headquarters were transferred to McKinney after about six weeks. Experiments were carefully planned and the details carried out at each location.

The experiments were designed to give information on the following points: time when applications should be made; frequency at which applications should be made; comparison of applications made under dew and dry conditions; comparison of early and deferred applications; comparison of materials; effect of strip-planting; and effectiveness of combination applications for boll weevil and flea hoppers. The season has been exceptional because of the absence of flea-hopper infestation

and in this respect has been much in contrast with 1926. The same experiments were carried out on certain weeds where the insects were more abundant and this will serve to check the work done on cotton. Indications point to little differences in yields of cotton as a result of the various treatments applied, because of the very light infestations. The records of the work show practically no advantage gained where fifth-day applications of sulphur were made as compared with applications made at seven-day intervals. The use of finely ground tobacco dust, pure or in combination with sulphur, has not proved to be as effective in controlling the flea hopper as sulphur alone. A superfine dusting sulphur continues to be the best remedy known. A comparison of applications made under dry conditions with those made when dew is present shows that the dew applications give little better control.

Hibernation of the Cotton Flea Hopper and the Boll Weevil

This is the second year in which emergence records have been taken in connection with the flea hopper. These records are of great value in showing the relative importance of the various host plants as sources from which an infestation of cotton flea hopper may come. Several new host plants have been added to the list, a tall-growing evening primrose (*Gaura brachycarpa*) found in South Texas being the most important. This weed was found to be about as attractive to the flea hopper when laying eggs as is the goatweed. More than 20,000 cotton flea hoppers hatched from eggs contained in 100 plants of each of these two species of weeds, an average of more than 200 flea hoppers per plant.

In the spring of 1927, about 75 per cent of the flea hoppers hatched before April 1 and before cotton was planted. This is the chief reason for the lack of injury by cotton flea hoppers in 1927. In 1926, the heavy emergence or hatching occurred just after cotton came up, and severe injury followed. More than 100,000 nymphs were counted during the emergence period, February 16 to July 3, when the insects were hatching from the over-wintered eggs. Weeds were collcted from several sections of the State and the records obtained on the emergence from 13 different host plants will soon be presented for publication in bulletin form.

The records on boll weevil survival and emergence as obtained at College Station have been given to the press at regular intervals by B. R. Coad, of the U. S. Department of Agriculture, Bureau of Entomology, with whom this Division is cooperating in this work. Early in the spring, indications pointed to the probability that boll weevls would be more abundant this year than at any time since 1921, which later proved to be a fact. Four thousand boll weevils were installed at the rate of 500 each week in eight cages from October 2 to November 20, 1926, and the emergence recorded from March 1 to June 12, 1927.

Control of Ants on Citrus Trees

This project was inactive for the most part of the year because there was no entomologist at the Lower Rio Grande Valley Station from June 1, 1926, to November 1, 1926, and as opportunity for working on this project is better in the early fall, little progress has been made.

Control of Scale Insects on Citrus

Oil emulsion made with canal water and according to the Government formula has not proved safe when spraying citrus in the Lower Rio Grande Valley. Experiments to determine the best schedule for spraying in which this formula was used had to be discontinued because of too much injury to the trees. A test to show comparison of materials was substituted and six spray mixtures were used, including four proprietary insecticides.

The fumigation experiments have been repeated. From the standpoint of scale killed, fumigation was quite satisfactory—a mortality of over 98 per cent resulting. It is not safe to fumigate during the spring or early summer. While good results can be obtained, this method does not appear to be practicable, because of the tendency for reinfestation to come from other groves not fumigated. The expense of annual fumigation is too high and tests are being conducted to determine the practicability of fumigation and spraying.

Mexican Fruit Fly

A very important insect was found on March 18, 1927, in grapefruit which had been shipped to College Station from the Lower Rio Grande Valley. The larvae pupated on March 21, 1927, and on April 5, adults were reared from the maggots found in these fruits and were identified as *Anastrepha ludens*, Loew. Adults were forwarded to Dr. J. M. Aldrich of the National Museum, Washington, D. C., for confirmation, which was made on April 16. This is believed to be the first discovery of this insect in citrus groves in the United States and the matter was immediately reported officially to the Chairman of the Federal Horticultural Board, to Mr. R. E. McDonald, of the State Department of Agriculture, and to Dr. L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture. Immediately a brief survey to determine the distribution of the pest was made and similar maggots were found in old and spoiled fruit from groves at Brownsville, La Feria, Mercedes, Donna, Weslaco, McAllen, and Mission, indicating a rather wide spread. Life-history studies were begun but were abandoned because of the inauguration by the United States Department of Agriculture of a campaign for complete eradication.

Boll Weevil Control by Use of Airplanes

During the season of 1927, this Division was fortunate in cooperating with two airplane companies—the Huff Daland Dusters, Inc., and the

G. C. Quick Dusters, Inc. The experiments were located, respectively, on the J. O. Chance Plantation in the Brazos bottom, Burleson County, and on the J. D. Rogers Cotton Breeding Farm, near Navasota. The control of boll weevils by this method was highly successful. Picking records have already shown yields of over 1400 pounds to the acre on the treated area as compared to 534 pounds to the acre on the untreated area of the Chance Plantation. Uncompleted picking records on the J. D. Rogers farm show a production of 1252 pounds of seed cotton to the acre on the dusted area to date, no cotton having been picked on the untreated area at this writing. A complete detailed report of this work will soon be presented in bulletin form.

Sulphur and Sulphur Compounds as Fungicides and Insecticides

As a result of a carefully outlined series of experiments, sulphur dust has proved to be superior to other dusts and combinations of dusts for controlling the cotton flea hopper. Control is obtained as a result of killing the younger forms of flea hoppers, adults and last stage nymphs not being greatly affected. Work the past season has been entirely in connection with cotton flea hoppers, but will be extended to include insects attacking truck crops.

Insect Pests of Corn and Grain Sorghum While in Storage

This project was approved November 30, 1926, and work begun soon thereafter. The object of this project is: to determine the relative importance of the insect pests of stored corn and grain sorghums; the rate of loss to the grain as a result of the presence of the insects; and to determine the most practical fumigation or control measures. Twelve varieties of corn are being used in these experiments, in which each variety has been stored under varying conditions. Some of the corn has been shucked, and selections of ears well covered and with short loose shucks have been made. Field-run samples were also taken and stored. The infestation on the shucked corn was so slight that practically no loss occurred after ten months' time. In the field-run samples there was a loss of 31 per cent in weight during the same period. All samples were kept in tight containers.

Foulbrood Inspection

During the year 1926-27, a total of 24,873 colonies belonging to 306 beekeepers were inspected. American Foulbrood was found in 203 colonies belonging to 48 beekeepers. All diseased colonies were destroyed. The work was carried on in 64 counties. Over 15,000 colonies were inspected for 43 queen-breeders. These men purchased 10,600 copies of queen-breeders certificates, this office supplying them at cost.

Life History and Methods of Controlling the Pecan Twig Girdler

The life history of the pecan twig girdler has been worked out and the length of the egg, larval, and pupal stages determined. The emergence

of the adults has been recorded over a period of years. Several parasites have been recorded and effective methods of control have been determined.

Life History and Control of the Pecan Nut Case Bearer

The information obtained from six years of study on the biology and control of this insect has recently been published in Bulletins 328 and 347 of this Station. The project was continued along two lines—a study of the parasites affecting this insect and control by the use of the airplane.

Beekeeping Investigations

The work under this project continues to be conducted at the State Apicultural Research Laboratory, located twelve miles east of San Antonio, in Bexar County, at the queen-rearing yard near San Antonio, and at the bee outyards located at Dilley, Frio County; Roxton, Lamar County; and Seguin, Guadalupe County. The work continues to be carried under the general project of Beekeeping Investigations, but under the following subdivisions of the project:

(1) Studies in Bee Behavior—response of bees to temperature, humidity, barometric pressure, and light.

(2) Studies in Bee Nutrition—honey plants, pollen plants, propolis, substitute foods; cultivation of such plants.

(3) Studies in Bee Breeding—all problems relating to queen breeding, drone influence, and relative subjects.

(4) Studies in Bee Products—honey, wax, beebread, propolis, royal jelly, and so forth.

(5) Studies in Bee Relationship.

(6) Studies in Bee Disorders—diseases, poisons, and accidents.

(7) Studies in Bee Economics.

(8) Studies in Bee Distribution.

(9) Studies in Beekeeping Equipment.

A number of experiments which were outlined the previous year were again carried on during the present year according to the subdivisions of the general project given above.

The climatic conditions during the year were about normal with reference to general farming. The dryness of January and February produced a mesquite honey flow and the heavy rains which occurred in May brought about a second flow, which gave a surplus of 70 pounds at the Laboratory. The spring was ideal for the starting of young plants and trees, but the general drouth which has existed during July and August has been very detrimental to their growth.

The spring count of bees in 1927 was 72 colonies at the Apicultural Research Laboratory, 52 colonies at Dilley, and 48 at Roxton. The colonies at the Laboratory furnished bees and combs for 150 nuclei at the queen yard, together with 12 colonies for breeders, and produced 3200 pounds of honey. Seven hundred queens were raised at the queen

yard, of which 300 were sold or traded, the remainder being used for experimental purposes. The bees at the Dilley yard have not as yet produced any surplus honey that can be removed, and the bees at the Roxton yard are still working cotton. The honey crop from these two yards cannot be removed before October.

The year 1926-27 has marked the beginning of the productive period of the work of the Apicultural Research Laboratory. There have been published during this time one bulletin, one circular, eleven numbered contributions, three articles approved but not numbered, thirty-six sets of news items relative to beekeeping for bee journals, and the annual reports for 1924-25 and 1925-26. A manuscript on ornamental plants for bee pasturage is in the hands of the editor, and five manuscripts are in such shape that they can be submitted in a short time.

Every division of the Laboratory work is in excellent condition. The most marked result of the experimental work is that the queens which have been selected through many generations and have been inbred to drones of known mothers show a very decidedly higher average of honey produced than the average colony of bees. As this condition has increased for each of the past three years, we are very hopeful as to the outcome of our method of selection of breeding queens.

AGRONOMY

Projects

1. Oat Investigations and Oat Improvement; State funds; P. C. Mangelsdorf, leader.
2. Rotation, Fertilizer, and Soil Improvement; State funds; E. B. Reynolds, leader.
3. Plant Introduction Studies; State funds; E. B. Reynolds, leader.
4. A Fundamental Study of Inheritance in Cotton; Adams and State funds; D. T. Killough, leader.
5. Crop Variety Tests; State funds; E. B. Reynolds, leader.
6. Time and Method of Intertillage; State funds; E. B. Reynolds, leader.
7. Time and Method of Seed-bed Preparation Studies; State funds; E. B. Reynolds, leader.
8. Crop Improvement; State funds; E. B. Reynolds, leader.
9. Rate and Distribution of Seed and Time of Thinning Cotton; State funds; E. B. Reynolds, leader.
10. A Study and Improvement of the Peanut; State funds; G. T. McNess, leader.
11. Composting Raw Rock Phosphate and Sulphur with Different Soils; State funds, and cooperative funds from the Freeport Sulphur Company; E. B. Reynolds, leader.
12. Rice Improvement and Method of Production Tests; State funds and cooperative funds from The Barrett Company; E. B. Reynolds and R. H. Wyche, leaders.

13. Inheritance in Grain Sorghums; Adams and State funds; A. B. Conner and R. E. Karper, leaders.

14. Wheat Breeding; State and Hatch funds; P. C. Mangelsdorf, leader.

15. Run-off Water Losses in Relation to Crop Production; Purnell funds; A. B. Conner, D. Scoates, and R. E. Dickson, leaders.

16. Inheritance of Head Characters in Kafir; Purnell funds; A. B. Conner and R. E. Karper, leaders.

17. Inheritance and Improvement in Corn; Purnell funds; P. C. Mangelsdorf, leader.

18. The Ginning of Cotton in Relation to the Market and Spinning Value of the Lint; State funds and Gin Sales; D. T. Killough and G. T. McNess, leaders.

Oat Investigations and Oat Improvement

Two varieties of oats developed at the Denton Station and first distributed to farmers in 1924 have rapidly increased in acreage and have, apparently, given satisfaction to growers. Nortex oat, a selection out of Red Rustproof, is adapted for either fall or early spring sowing. Though a typical Red Rustproof oat in appearance, it is a few days earlier in maturity than the common run of Red Rustproof oat and this characteristic enables it to escape, to some extent, severe stem-rust infection. A comparison of the average yield of Nortex oat with T. S. No. 1415, known to be a high-yielding variety, shows that as an average for four years, 1923 to 1926, inclusive, Nortex oat yielded 94.46 bushels to the acre, while T. S. No. 1415 yielded 90.27 bushels to the acre.

The winter of 1926-27 at Denton was characterized by several severe freezes, which caused pronounced heaving of the soil. Under these conditions, Nortex failed to survive as well as several of the common, mixed varieties grown at that Station. In spring plantings, however, it again made an excellent showing. An estimated crop of 12,000 bushels of seed of Nortex was produced in 1927. Application for registration of this variety was made to the American Society of Agronomy and has been granted.

Frazier oat, a selection from a variety of oats obtained from the farm of Mr. Tom Frazier, Morgan, Texas, was first distributed in 1924. This oat resembled Fulghum oats in type of plant and date of maturity, being 8 to 10 days earlier than Red Rustproof. It is not recommended for fall planting, but as a spring-sown oat it has produced excellent yields. A comparison of the yields of Frazier and Fulghum oats shows that as an average of six years, 1921 to 1926, inclusive, Frazier made an average yield of 67.31 bushels to the acre, while Fulghum made an average yield of 62.19 bushels to the acre. An estimated crop of 15,000 bushels of this variety was available in 1927. The Frazier oat has been registered as an improved variety by the American Society of Agronomy.

Hybrids of winter and spring varieties of oats, made by the U. S. Department of Agriculture, have been grown at Denton since 1923, and

selections have been made from these hybrids and have been tested in the rod-row nursery. Several of the selections have shown marked resistance to smut and from this standpoint are very promising.

Oat blast, a condition in which parts of the spikelets fail to develop seed, was unusually severe at the Main Station Farm in 1927. The degree of damage varied with different varieties, the percentage of blasted spikelets ranging from 5 to 30 per cent. A study to determine whether susceptibility to oat blast is inherent in varieties or whether it depends upon the stage of development of the varieties under certain weather conditions is being made.

Rotation, Fertilizer, and Soil Improvement Investigations

(a) **Rotation and Fertilizer Experiment, Main Station.**—This experiment has been conducted since 1914. It consists of a four-year rotation of corn, oats (cowpeas), cotton, and cowpeas and continuous cotton and continuous corn. Seven different treatments are used: acid phosphate; acid phosphate and cottonseed meal; acid phosphate and manure; rock phosphate; rock phosphate and manure; manure alone; and crop residues removed. These treatments are given to each crop in the rotation.

In 1926 the yields of rotated cotton ranged from 237 to 362 pounds of lint to the acre, and the yield of continuous cotton was from 275 to 387 pounds. The largest yield in the rotated cotton, 362 pounds, resulted from the treatment of 5 tons of manure, while the highest yield in the continuous cotton, 387 pounds, came from the plat treated with rock phosphate alone.

For the 12-year period, 1914-1926, omitting 1920, the application of 5 tons of manure and 200 pounds of acid phosphate produced the highest yield, 224 pounds of lint to the acre, in the rotated cotton. In the continuous cotton, the three plats which received nitrogenous materials produced the best yields, all being about 180 pounds of lint to the acre, for the twelve years. As an average of all the treatments, rotated cotton produced 200 pounds of lint to the acre, and continuous cotton produced 170 pounds to the acre, for the 12 years, a gain of 30 pounds to the acre yearly for the rotated cotton.

The largest yield of rotated corn, 21.8 bushels, in 1926, resulted from the treatment of 200 pounds of acid phosphate and 100 pounds of cottonseed meal, but the yields ranged down to 8.6 bushels to the acre. In continuous corn the treatment of manure and acid phosphate produced the highest yield of corn, 18.9 bushels to the acre. For the thirteen years of the experiment, rotated corn has produced an average of 21.6 bushels, and the continuous corn 15.5 bushels to the acre, or 6.1 bushels in favor of rotation.

In 1926 determinations were made of the amount of nitrate nitrogen in the soil of the different plats in this experiment. It was found that the yields of cotton and corn for a period of years were correlated with the quantity of nitrate nitrogen in the soil.

The results secured in this experiment to date indicate that the soil

needs both nitrogen and phosphoric acid, in the order named. The fertilizers used have not been profitable.

(b) **Fertilizer Experiments at Angleton, Beeville, and Nacogdoches.**—In this work fertilizers have been applied to cotton and corn with the object of determining the best analysis (grade) of fertilizer and the most profitable amount of fertilizer to use in these crops. In 1926, the work was satisfactory at all three points.

At both Angleton and Beeville, the results secured in 1925 and 1926 show that phosphoric acid is the first limiting element in crop production. Applications of 200 pounds of acid phosphate to the acre made larger increases in yield, 71 pounds of lint cotton, than 100 pounds of sulphate of ammonia or 40 pounds of muriate of potash per acre, and as large increases in yield as a combination of these three materials. The application of 200 pounds of acid phosphate was the most profitable fertilizer treatment used on cotton, producing a profit of $8.40 to the acre at Beeville and $4.20 to the acre at Angleton for the two years.

The results with cotton at Nacogdoches show that a fertilizer containing about 8 per cent of phosphoric acid, 4 per cent of nitrogen, and 4 per cent of potash (an 8-4-4 fertilizer) at the rate of 400 pounds to the acre was the most profitable fertilizer used, since this treatment made an annual profit of $5.15 to the acre for the three years, 1924, 1925, and 1926.

(c) **Soil Fertility and Moisture Conservation Studies at Lubbock and Spur.**—The object of this work is to find a suitable cropping system or systems, including soil-improving crops and practices, best adapted to conditions prevailing in northwestern Texas. At Lubbock there are 25 different cropping systems in which cotton and feterita are the crops used. Each of these two crops is grown continuously on the land with and without manure or alternates with fallow or green manure. Other cropping systems are embraced in rotation in certain crop sequence involving two, three, and four-year rotations. The work was established in 1914.

The work was satisfactory at Lubbock in 1926. The largest yield of cotton was 354 pounds of lint to the acre in a two-year rotation of cotton and green manure. The yields, however, ranged from 200 to 354 pounds of lint to the acre. The largest yield of feterita, 40.4 bushels to the acre, resulted from a three-year rotation of cotton, feterita manured, and fallow, but the yields ranged down to 17.3 bushels to the acre in the rotation of cotton, feterita, and green manure.

For the 12-year period, 1915 to 1926, the three-year rotation of cotton, feterita, and fallow manured has produced the highest average yield of cotton, 291 pounds of lint to the acre. The largest yields of feterita have been produced where manure has been used in the cropping system. For instance, the following rotations, all of which include the use of manure, each have made an average yield of about 30 bushels of feterita to the acre for the 12 years; feterita manured after fallow; cotton,

fallow, feterita manured; cotton, feterita manured, fallow; and cotton manured, feterita, fallow.

The results of the work for the 12-year period indicate that fallow is not necessary in the agriculture of the region, and that so far green manure has not been profitable. It would appear from these results that the most practicable cropping system for the region is the alternate cropping of cotton and the grain sorghums, using such manure and crop residues as may be available.

(d) **Rotations.**—The results with rotations have been published in Bulletin No. 365, "Crop Rotation in the Blackland Region of Central Texas." In this bulletin it is shown that cotton, corn, wheat, and oats produced larger yields in rotation than when grown continuously on the same land year after year as shown in 11 years of experiments with several rotations at Temple, Texas. Yields of cotton have been doubled; yields of corn increased 87 per cent; wheat, 55 per cent; and oats, 17 per cent by rotations, as compared with continuous cropping. Rotation of crops reduced root rot of cotton from 39.7 to 4.8 per cent. Rotation or changing of crops on the land appears to offer the most promising immediate solution of the problem.

The crops in the three-year rotation of cotton, corn, and oats brought the highest comparative net profit per acre, $15.96, annually for a period of six years. Cotton planted on the same land continuously showed an average yearly comparative net profit of $7.33 per acre; corn planted continuously, $2.32 per acre; oats planted continuously, $2.25 per acre; and wheat planted continuously, $2.02 per acre.

Plant Introduction

Plant introduction was carried out in the usual manner at the Main Station and at the substations in 1926. Subterranean clover continues to be successful at the Main Station, Substation No. 4, and Substation No. 11. *Andropogon annulatus,* which has been given the name "Angleton Grass," has been grown at Angleton since 1915. It has been found well adapted to the central and eastern parts of the Gulf Coastal Plains in Texas. It is at this time attracting considerable attention as a promising forage crop for dairy cattle and other livestock in this region. The results secured with Angleton grass have been published in Bulletin No. 342, "Angleton Grass."

A large number of grasses are being tested out at the Angleton Station in cooperation with the Office of Forage Crops Investigations, U. S. Department of Agriculture. Some of these appear to be promising for conditions in the Gulf Coast region of Texas.

A Fundamental Study of Inheritance in Cotton

(a) **Variation and Inheritance in Lint Characters in Cotton.**—The results of studies made on the variation in certain lint characters in an inbred plant of Mebane cotton and its progeny have been published in

Bulletin No. 349, "Variation in Certain Lint Characters in a Cotton Plant and Its Progeny." It was found that the lint from different bolls on different parts of the same plant and even in the same boll, and on the same seed, varied considerably in length. These variations were found to exist in both the parent and its progeny. The percentage of lint was not as variable as was the length of lint. Considerable variation was found in the length of lint produced by seeds of the parent plant as well as by seed produced by the progeny; the mean length of lint of the progeny approached closely that of the parent, indicating that this character is inherited. The results show that the average performance of the plant, and not that of the individual bolls, should be considered as a unit in making selections for breeding purposes.

In studying the variation and inheritance of certain characters in Belton cotton, within a population composed of 1,586 individuals, a considerable amount of variation was found to occur in the percentage of vegetative branches and percentage of five-lock bolls; while a relatively small amount of variation was found in the percentage and the length of lint. There appeared to be a fairly significant positive correlation between the number of vegetative branches and height of plant; between the percentage of five-lock bolls and height of plant; and between the length of lint and percentage of five-lock bolls. A rather high and significant negative correlation ($-.79 \pm .02$) was found between length of lint and percentage of lint, indicating that it was not possible to select for lint in Belton cotton longer than 1 1/16 inches, without decreasing the percentage of lint. The percentage of five-lock bolls and the percentage of lint appeared to be inherited, as indicated by fairly significant positive correlations between parent and progeny.

(b) **Inheritance of Quantitative and Qualitative Characters.**—The following characters are being studied on a number of hybrid and parental lines of cotton in the first to ninth generations:

1. Yield.
2. Percentage of lint.
3. Length, strength, and uniformity of lint.
4. Size of boll.
5. Percentage of 4- and 5-lock bolls.
6. Earliness as measured both by daily bloom count and open boll count.
7. Height of plant.
8. Number of vegetative and fruiting branches.
9. Height of first fruiting branch from the ground.
10. Lint index.
11. Length of internode.
12. Color of flowering parts.
13. Shape, size, and color of leaves.
14. Hirsuteness.
15. Storm resistance.
16. Type of boll formation.

Some of the hybrid lines have not yet become uniform with respect to certain vegetative characters, even after six inbred generations. There has been no noticeable decrease in the vigor of the plants after six years of inbreeding. A single factor appears to be involved in the expression of the characters, percentage of lint, color of lint, color of plant, cluster-type of boll formation; while two or more factors seem to be involved in the expression of such characters as seed fuzziness, pubescence, and petal spotting. Linkage was observed between the seed fuzziness and percentage of lint.

(c) **Hybridization Studies.**—In 1926 and 1927 a number of crosses were made to study the inheritance of the following characters:

1. Virescent yellow leaf X normal green leaf.
2. Brown lint X white lint.
3. Red leaf X virescent yellow leaf.
4. Long lint X short lint.
5. Early maturity X late maturity.
6. Large boll X small boll.
7. Slick seed X fuzzy seed.
8. Leaf showing plastid chlorophyll deficiency X normal green leaf.
9. Cluster-type X non-cluster type.

The F_1 plants of the crosses made in 1926 were studied with the following results: In the cross, virescent yellow leaf X normal green leaf, the latter was completely dominant. Red leaf was completely dominant to virescent yellow leaf, and normal green leaf was completely dominant to leaf showing plastid chlorophyll deficiency. The remainder of this material is not yet ready for analysis.

(d) **Study of Seedling Vigor.**—A number of cotton plants having leaves showing varying degrees of chlorophyll deficiency were self-fertilized in 1926 and the F_1 plants grown in 1927. Approximately 25 per cent of the F_1 plants were small, not thrifty, and these died two weeks after germinating, the cotyledons and first adult leaf being pale green and yellow in color, with some areas of the leaf completely devoid of chlorophyll. Less than 50 per cent of the seed from the parent plants germinated. A study is being made of this type of chlorophyll deficiency, to determine its inheritance. Strains of cotton containing plants showing chlorophyll deficiencies should be discarded, since seed from such plants are not vigorous, resulting in poor stands of unthrifty plants.

(e) **Studies of Pedigreed Line-bred Progenies.**—One hundred and ten pedigreed rows of Startex cotton were studied with respect to yield, length of lint, percentage of lint, size of boll, percentage of five-lock bolls, height of plant, percentage of fruiting and vegetative branches, height of first fruiting branch from the ground, lint index, length of internode, early maturity, and storm resistance. Simple and multiple correlation methods are now being used to analyze these data to deter-

mine the degree to which these characters are inherited, and to furnish information which will form a basis upon which future improvement can be made. A number of promising pedigreed lines have been isolated by self-fertilization which are characterized by high yields of lint; high percentage of large five-lock bolls, 45 to 50 being required to weigh one pound; early maturity; percentage of lint ranging from 40 to 44 per cent; and length of lint measuring from 1 to 1⅛ inches. This material should be aivalble for publication at an early date.

Crop Variety Tests

The usual tests with varieties of different crops were conducted at the Main Station Farm and at the substations during the year 1926. The results with several crops are given as follows:

(a) **Variety Tests with Cotton.**—These tests were conducted at the Main Station, College Station, and at all the substations in 1926 with satisfactory results. The data summarized for all the stations to date continue to show that types of cotton such as Mebane, Lone Star, Truitt, and Acala have a wide adaptation and are generally well suited to conditions in Texas. Varieties and strains of cotton have more or less local adaptation. For instance, strains of the Rowden type, such as Belton, Sunshine, and Rowden, are well adapted to East and North Texas, but are not well suited to conditions in Northwest Texas, where strains of the Mebane type of cotton have given best results. The strains of Mebane type, Mebane, Kasch, Cliett, and New Boykin, are well adapted to conditions in the humid part of the Gulf Coastal Plains of Texas. Those varieties of cotton which have originated in the eastern cotton-growing states, as a general rule, have not been profitable in Texas, except in sections where the rainfall is abundant or irrigation is practiced. Bulletin No. 354, "Varieties of Cotton for the Gulf Coastal Plains of Texas," Bulletin No. 364, "Varieties of Cotton in Northwest Texas," and a forthcoming Bulletin No. 366, "Varieties of Cotton in the Red Prairies of Northwest Texas," furnish information on the results of the variety tests of cotton for periods of eight to 15 years, at the Angleton, Lubbock, and Chillicothe Stations.

Fiber tests are being continued on the varieties of cotton, on cotton receiving different fertilizer treatments, and also on bolls of cotton maturing at different dates, to determine the effect of fertilizers and time of maturity on the grade, length, strength, and spinning value of cotton fibers.

(b) **Variety-date Test of Corn.**—This test was again conducted at the Main Station and at the substations in 1927, making the tenth year for the experiment. It is believed that this test has now been conducted for a sufficient length of time to draw reliable conclusions and that its discontinuance is warranted. The data are now being analyzed for publication as a Station Bulletin. A preliminary analysis of yields indicates that the early plantings always average higher than the later

ones, over a period of years, though the medium and late plantings give better results in some seasons. The loss in yield due to late planting varies with the locality, the season, and the variety. It has ranged from 24 per cent at Angleton to 33 per cent at Nacogdoches when all varieties are averaged together. Surcropper has shown the smallest reduction in yield due to late planting, averaging 18.1 per cent at Angleton, Denton, and Nacogdoches, as compared to 32 per cent for Brazos White and Oklahoma White Wonder. For eastern Texas the varieties Brazos White, Hastings' Prolific, Ferguson Yellow Dent, and Fentress Strawberry appear to be the best for early planting. For late planting Surcropper has proved to be the best variety tested.

(c) **Variety Test of Cowpeas.**—A summary of the results of variety tests of cowpeas at the substations continues to show that New Era, Brabham, Early Buff, and Blackeye are good varieties for conditions in Texas. Chinese Red is one of the highest-yielding varieties at Substation No. 1, Beeville, and, as a consequence, it has been distributed rather widely in the surrounding region. Perhaps New Era, Groit, and Brabham are better adapted to all of the conditions in the State than the other varieties.

Time and Method of Intertillage Experiments

As in previous years, this experiment is carried at Chillicothe, Lubbock, Spur, and Beeville. The results for the nine years, 1918-1926, inclusive, continue to show that weeds are the principal consideration in tillage operations, and these results indicate that just enough cultivation to control weeds effectively is the best kind of tillage. The ordinary cultivator is perhaps the most effective implement for this purpose.

Time and Method of Seed-bed Preparation

This work has been conducted since 1918 at Chillicothe and Lubbock. The field work was satisfactory in 1926 at Lubbock, but it was necessary to abandon the test at Chillicothe on account of poor stand resulting from unfavorable soil conditions. At Lubbock, late deep plowing (7 inches) made the largest yield of cotton, 265 pounds of lint to the acre, while shallow plowing at a medium early date gave the highest yield of milo, 31 bushels to the acre. During the nine years, 1918-1926, inclusive, late deep plowing produced the largest average yields of cotton and milo, 265 pounds of lint cotton and 23 bushels of milo to the acre, annually at Lubbock.

The general conclusions from these investigations to date are that medium to late preparation of the seed-bed to a medium depth, 5 to 7 inches, gives best results on soils that do not blow. On soils having a tendency to blow, late preparation is advisable.

Crop Improvement

Crop improvement work was again done at most of the substations in 1926. Work is being continued with Westex cotton, a selection from a field of Burnett cotton at Lubbock in 1921. This variety has been increased and seed distributed, particularly to the counties north and northwest of the Station, where there has been, in very recent years, much interest in cotton-growing for the first time and where an early variety is essential to success. It is believed that the particular value of this variety will be that it will make possible the profitable growing of cotton fifty to one hundred miles to the north and northwest, where other varieties are now uncertain. Some high-yielding strains of Startex cotton are being developed at the Main Station Farm, College Station. As has been noted in previous reports, the improvement of Thomas corn is being continued at Substation No. 1, Beeville, and due to these efforts, Thomas corn is generally distributed in that section of Texas.

Rate and Distribution of Seed and Time of Thinning Cotton

During the year two Station bulletins were published in connection with this project. These are: Bulletin No. 340, "The Effect of Spacing on the Yield of Cotton," and Bulletin No. 360, "The Effect of Spacing and Time of Thinning on the Yield, Growth, and Fruiting Characteristics of the Cotton Plant in 1925." The following results are reported in Bulletin No. 340:

In 1914, the Division of Agronomy, Texas Agricultural Experiment Station, began the experiments here reported to determine the optimum spacing of cotton under the conditions prevailing in different parts of the State, and also to determine the effect of deferred or late thinning on the yield of cotton. The field work in these experiments was done at the Main Station, College Station, and at the substations at Beeville, Troup, Angleton, Temple, Spur, Lubbock, Pecos, Nacogdoches, and Chillicothe. This bulletin reports the results of this work up to the present time.

Statistical methods were used in analyzing and interpreting the data obtained in the experiments. The use of these methods makes it possible to reach more definite conclusions than would have been possible otherwise.

The highest yields in general resulted from the close and medium spacing, 6 to 21 inches, in the different parts of the State, except in eastern Texas, where comparatively wide spacings, 27 to 36 inches, gave the best results. Twelve inches was found to be the optimum spacing at Angleton, Lubbock, and Spur; 9 to 12 inches at College Station; 21 inches at Beeville and Temple; 27 inches at Nacogdoches; and 30 inches at Troup and Chillicothe.

These results show that the cotton plant has the ability to adjust itself to produce satisfactory yields within a comparatively wide range of spacing.

Thinning cotton at the usual time of thinning produced larger yields in general than late or deferred thinning.

Bulletin No. 360 reports the results of work conducted in 1925 at the Main Station Farm, College Station, to determine the effect of spacing and of time of thinning on the yield, growth, and fruiting characteristics of cotton.

Late thinning in this test had the effect of stunting the cotton plants, in general causing them to produce fewer branches, particularly vegetative branches, shorter vegetative and fruiting branches, to produce their first branches higher from the ground, and to have smaller plants both in height and diameter, than plants thinned at the normal or usual time of thinning. In short, late thinning either prevented or retarded the development of both vegetative and fruiting branches, as compared with normal thinning.

Cotton thinned at the usual, or normal time, produced blooms and open bolls earlier and also produced an earlier crop and larger yields than the late-thinned cotton. The close and medium spacings, from 9 to 18 inches, produced the earliest crop. In general, the size of bolls increased as the distance between plants was increased.

These results show that there were no advantages gained by late thinning. If, however, cotton must be thinned late through uncontrollable circumstances, the results indicate that it would be better to leave more plants to the row than is normally the practice. More stunted plants can be left on an acre without crowding than can plants which grow normally.

The Study and Improvement of the Peanut

There was practically a failure of the peanuts in this project in 1925 and the seed obtained were used as increase in 1926. Consequently, no additional progress can be reported for the crop season of 1926.

Composting Raw Phosphate Rock and Sulphur with Different Soils

The results of this work to date show in general that sulphur as a fertilizer has no significant effect on decreasing or increasing the yield of cotton, corn, and oats, when used in amounts up to 1,500 to 2,000 pounds to the acre, but larger amounts reduce the yields. These results indicate that sulphur is not needed as a fertilizer on the soils to which it has been applied in Texas.

Rice Improvement and Methods of Production Tests

The work under this project was continued at Substation No. 4, Beaumont, during 1926, in its several phases. Results secured have in large measure been a confirmation of results secured in previous years. Over a period of years, Blue Rose, Texas Fortuna, Early Prolific, T. S. No. 5411, a Japanese rice, and Honduras have been the varieties best adapted to conditions at Beaumont. Lady Wright continues to be a popular variety of rice with farmers, on account of its good milling

quality, early maturity, its long, uniform, cylindrical grain, and the fact that it commands a premium on the market. Its yield, however, has not been as high as for some other varieties. The results with fertilizers for rice continue to show that 100 pounds of sulphate of ammonia is the most profitable treatment.

Wheat Breeding

Breeding work with wheat at Substation No. 5, Temple, has been discontinued and the most promising material transferred to Substation No. 6, Denton, where facilities are better for this work. The breeding operations at Denton have reached the point where characters, other than yield, as for example, milling and baking quality, resistance to leaf or stem rust, and resistance to lodging, are as important as yield in determining which of the selections are worthy of distribution.

Denton wheat again made an excellent showing at the Substation and in the fields of farmers to whom it has been distributed. The total supply of seed of this new variety was somewhat less than 1,000 bushels, and the demand for seed has been much greater than the supply of seed. The seed grown on the substation farm has been distributed mainly to county agents outside of Denton County in order to get the variety disseminated to other parts of the State. Denton wheat continues to show good yielding ability, resistance but not immunity to stem rust, and has made an excellent showing in the milling and baking tests. Denton wheat has been registered as an improved variety by the American Society of Agronomy.

Leaf rust was unusually severe at Denton both in 1926 and 1927, and it appears that this disease must be regarded as equal to or more important than stem rust in Texas. Many of the selections in the rod-row nursery were so severely injured that they failed to head out. Several strains have shown marked resistance to leaf rust, and one in particular, 3015-63, has exhibited almost complete immunity, except for occasional susceptible plants which can probably be eliminated by again pure-lining the strain. This selection has yielded well in the nursery rows and has been increased in the field plats, and has also been used in making hybrids with other strains. Mr. C. O. Johnston, of the Bureau of Plant Industry, who is cooperating in the leaf-rust studies, reports that several of the Texas Station selections, including 3015-63, have proved resistant to leaf rust in other states where he has grown them and that they have, in addition, made excellent yields.

Stem rust, although not as severe as in some years, was present, and it was possible to determine the relative resistance of many of the selections. T. S. No. 3015-106, which had previously been one of the most promising selections from the standpoint of yield and good appearance in the field, and which has been distributed on a preliminary scale, proved to be extremely susceptible to stem rust in 1927 and has been withdrawn from distribution. Denton wheat showed marked resistance to stem rust, but did not prove to be entirely immune.

Milling and baking tests made from samples of the 1926 crop of Mediterranean and other selections indicate that Denton wheat is an excellent milling and baking wheat, producing a high percentage of flour, a loaf of large volume and good color and texture. T. S. No. 3015-106, which is almost equal to Denton in yield, proved to be inferior in milling and baking tests.

Inheritance and Improvement in Corn

This is a new project established in 1927 supported by Purnell funds, for the purpose of (1) improving locally adapted varieties of Texas corn, and (2) conducting fundamental studies of inheritance in corn. Approximately 5,000 ears were artificially self-pollinated at College Station and at four substations.

Improvement in corn can be most successfully brought about by inbreeding a variety during four or five successive generations, and later recombining the best inbred strains. Inbreeding concentrates the heredity, eliminates inherited abnormalities, but results in decreased vigor. Crossing the inbred strains restores vigor and results in increased yields. Inbreeding has been started at College Station and at five of the substations and approximately 1,000 lines of six varieties of corn, 100 lines of each variety being grown at each station, as follows:

Angleton—Surcropper, Tuxpan.
Beeville—Surcropper, Thomas.
Denton—Surcropper, Yellow Dent.
Nacogdoches—Surcropper, Nacogdoches.
Main Station—Surcropper, Blue Grain T. S. No. 935.

In spite of adverse weather conditions at several of these points, a large proportion of the pollinations were successful and a satisfactory set of seed was obtained from a majority of the ears.

Although the main object of this work is to isolate the highest-yielding strains, and selection is based mainly on yield, observations on other characteristics have been recorded which may facilitate future breeding work.

The 100 lines of Surcropper at each station originated from 100 ears of this variety obtained from the Ferguson Seed Farms, Sherman, Texas. By inbreeding these strains from the same source under five different sets of environmental conditions it should be possible to determine some of the effects of environment on the characteristics of the strains isolated by inbreeding. The following inherited abnormalities have already appeared in these strains and will be permanently removed from the variety: white seedlings; golden plants lacking chlorophyll; tassel-seed plants in which the seed is borne in the tassel instead of the ear; defective seeds; germinating seeds; and branched ears. In addition, sweet corn seeds have been eliminated from a variety of field corn, yellow seeds from a white-seeded variety, red cobs from a white-cobbed variety, and white cobs from a red-cobbed type.

To determine whether crossing varieties before they have been inbred

will give a sufficient increase in yield to justify this practice, the following varieties have been crossed with Surcropper: Early Butler, Chisholm, Horton, Thomas, Ferguson Yellow Dent, Fentress Strawberry, Virginia White Dent, Oklahoma White Wonder, Blue Grain, and Hasting's Prolific. These hybrids will be tested for yield the following season.

Studies of inheritance in corn consist chiefly of the following problems:

1. Sugary endosperm, which is ordinarily inherited as a simple Mendelian recessive and appears in hybrid progenies in the ratio of 75 per cent starchy to 25 per cent sugary has segregated in one progeny in the ratio of 36 per cent starchy to 64 per cent sugary. Recessive seeds from this progeny have bred true. Starchy seeds from the same progeny have again segregated giving a wide range of ratios from 25 per cent to 75 per cent sugary. Reciprocal back crosses of segregating plants with the recessive parent do not give identical results, the cross *Su su X su su* always producing a lower percentage of recessive than the cross *su su X Su su*. A population of over 150,000 has been classified during the past season and a preliminary paper on the results of this study is now being prepared for publication.

2. Crosses among eleven genetically distinct types of prematurely germinating seeds indicate that complementary and multiple factors are involved. A total population of 35,000 has been classified during the past season and ratios of 3:1, 9:7, 27:37, 15:1, 63:1, 255:1, 45:19, and 135:121 have been obtained. The last two ratios are the result of interaction of one pair of complementary factors with two and three pairs, respectively, of multiple factors and are Mendelian ratios which apparently have never been previously reported.

3. Plants of an F_1 hybrid of sugary endosperm X Rice Pop, which regularly produce a ten per cent deficiency of sugary seeds, were divided into two groups. In one group the silks were pollinated at the usual length; in the other the silks were cut back to the tip of the ear. The short-silked group produced 12 per cent recessives; the long-silked group 15 per cent, indicating further that differential pollen tube growth is the underlying cause of the deficiency of recessives always found in this cross.

4. A study of the rate of development, earliness of blooming, length and weight of ears from F_1 plants, half of which were heterozygous for a lethal factor, and half, homozygous for its dominant allelomorph, while all other genetic factors were identical, indicates that recessive lethal factors have a slight but definite depressing effect in the heterozygote. Many recessive variations are removed from a variety during inbreeding and a knowledge of the probable effects of this procedure is important in practical breeding. A paper on "The Effects of a Lethal Factor on the Heterozygote in Maize" has been prepared for publication in the Journal of Heredity.

The Ginning of Cotton in Relation to the Market and Spinning Value of Lint

This study is being made to determine the effect of the speed of the saws, the effect of the use and non-use of the cleaning apparatus, and the condition of the roll (tightness) on the percentage, grade, length, and spinning value of the lint. Eighteen conditions of ginning are provided and samples have been collected for the past two years. Spinning and fiber tests are now being made on the lint from these conditions of ginning. The results to date show that where optimum conditions of ginning are provided the market value of the lint is increased from five to seven dollars a bale. It is contemplated that these results will be submitted for publication at an early date.

Production of High Nicotine Tobacco

The object of this work is to compare and determine the relative value of N. tobaccum and N. rustica with regard to nicotine content, yield from different methods of planting, and for seed production. The field work is being done at Substation No. 16, Iowa Park, Texas, in co-operation with the Tobacco By-Products and Chemical Corporation, Louisville, Kentucky. The work was started in the spring of 1927. Samples of the various tobaccos grown in the project have been collected and are now being analyzed for their nicotine content.

Inheritance in Grain Sorghum

Further hybrids have been made during the year within a parallel series of strains of the different varieties and groups of grain sorghums, including Blackhul kafir, Yellow milo, White milo, feterita, and Kaoliang, with a view of determining the mode of inheritance of height when crosses between strains of the different statures within a variety are made. Notes on these crosses will also furnish a measure of hybrid vigor resulting from additional crosses between this height series in the sorghum.

The inheritance of chlorophyll deficiency in a hybrid between virescent yellow and normal green kafir plants has been given further study during the year. Virescent yellow is recessive to normal chlorophyll development. From fourteen F_1 plants which were grown last year, a total of 10,614 seedlings were germinated in flats in the greenhouse, 1,453 of which were virescent yellow, giving a ratio of 7.3:1, which cannot be explained on any single factor hypothesis but may indicate linked duplicate factors with approximately 25 per cent crossing over. It is planned to grow the F_2 generation of this material to maturity in order to obtain seed for verification in the F_3 generation.

Correlation studies between each of eleven pairs of head and plant characters in kafir have been made with population material of Standard Blackhul kafir, including 1,066 plants, and pure line material of Line 223, including 100 plants. The correlation coefficients of these two sets

of material are in rather close agreement, and, when the large population is considered, show positive correlations of the zero order as follows:

Weight of Head and Length of Head	.70 ± .01
Weight of Head and Length of Seed Branches	.59 ± .01
Weight of Head and Height of Plant	.30 ± .02
Weight of Head and Diameter of Plant	.38 ± .02
Weight of Head and Weight of Green Forage	.72 ± .01

Multiple and partial, or net, correlation coefficients have been calculated for this same set of material and, while a positive relationship is shown between yield and all of the characters listed above, the size of the correlation coefficient is considerably less in each instance. Significant partial correlation coefficients of .30 ± .02 and .34 ± .02 are shown between the weight of head and length of head and weight of head and weight of green forage, respectively. The net coefficients between yield and the other characters studied are relatively small and indicate comparatively little bearing of these characters on yield of grain produced.

Hybrid vigor in sorghum, as indicated by height of plant, was measured by crosses between closely related strains of the same variety of sorghum, differing markedly in height of plant but otherwise having almost identical varietal characteristics, and also in crosses between varieties more remotely related and having markedly different varietal characteristics. Plants from the inter-varietal crosses in the F_1 generation exhibited marked hybrid vigor, being, in some cases, approximately double the height of the tall parent. Hybrid vigor was pronounced in F_2 but was not so marked as in F_1. Crosses between Extra Dwarf Milo and Standard milo, strains of the same variety but differing in height, exhibited no heterosis in either the first or second generation. Extra Dwarf milo, crossed with Dwarf milo, two parents differing in height by twenty centimeters, showed increased height of plant, especially in the F_1 with a slight increase in the F_2. Apparently the increased height is an expression of two or more complementary height factors. Hybrids between Extra Dwarf feterita and Standard feterita, two strains of the same variety differing widely in height, displayed no heterosis in either the first or second generation, the tall parent showing a simple dominance and segregating in a 3:1 ratio in the F_2. In characteristics other than height, such as color, diameter of plant, root system, size and number of leaves and size of panicles,—the intervarietal crosses exhibited marked hybrid vigor while these evidences were lacking in the intravarietal crosses. Unlike hybrid corn plants, however, hybrid sorghums which exhibit hybrid vigor are considerably later in maturity than their parents.

Hybrid vigor in sorghum crosses is apparently retained in later generations and the recovery of desirable recombinations retaining vigor and desirable growth factors, therefore, offers opportunity for improvement. This study will be of interest to plant breeders in the develop-

ment of new strains and varieties of sorghums through hybridization. It will be of further interest also to the farmer in enabling him to so arrange his seed fields in such a way that roguing the first-year hybrids will be facilitated and the maintenance of pure strains in increase fields can be more readily accomplished.

Crosses between two inbred lines of kafir, which had undergone eight generations of inbreeding, gave no evidence of heterosis and ten generations of inbreeding has shown no perceptible reduction in vigor. Crosses between milo and feterita, both of which are classed in the durra graup, display much more marked heterosis than crosses between kafir and feterita, which are assigned to different groups in the present sorghum classification. The phenomenon of hybrid vigor promises to aid in a more adequate classification in this crop.

Inheritance of Head Characters in Kafir

Work on this project during the year has included the completion of taking the original measurements on number of seed branches, number of nodes, length of rachis and length of seed branches of a large number of kafir heads in the F_3 generation. Progress has been made in the calculations of the statistical constants of each of the populations comprising the progeny of two hundred and fifteen second-generation rows. These data are being analyzed in an endeavor to determine the inheritance of the characters studied.

Run-off Water Losses in Relation to Crop Production

The study of the factors concerned in the loss of water by run-off and the relation of this loss to crop production is the object of Project No. 209, Run-off Water Losses in Relation to Crop Production, carried under the Purnell fund. The chief factors studied are the intensity of the rainfall, the slope of the land, the condition of the land, and the efficiency of obstructions of various kinds which may retard the running off of water.

This work is carried at Substation No. 7, located near Spur, on a soil representative of what may be termed as the northwestern rolling plains, consisting mainly of dark soils. The equipment consists of a series of small plat areas, bordered by sheet iron, with tanks located on the lower side to catch the loss of water and soil. These areas, consisting of a battery of eight plats, have varying slopes and grades, and varying crop treatment, and are used as a basis for determining the amount of loss of water and soil under different conditions. A series of plats ranging from 6 to 12 acres in size, the whole series embracing more than 100 acres of land, with different systems of terracing for the study of the effectiveness of different methods of preventing the loss of water, are being used. On six of these areas the water loss is obtained by means of weirs and automatic water-stage recorders.

The work the first year may be considered as of a preliminary nature,

but it is indicative of the importance of the problem. With a rainfall of 27.42 inches, from June 19 to December 31, 1926, as compared to the normal rainfall for the same period of 13.51 inches, the run-off-water losses from level, 1 per cent, 2 per cent, and 3 per cent grades, where the land was planted to cotton, were 5 per cent, 27 per cent, 28 per cent, and 22 per cent, respectively. The inconsistencies of the two greatest slopes is probably due to the fact that excavations and filling were necessary in establishing these grades. The results indicate that one of the most important factors concerned in the loss of run-off is the rapidity of the fall of water. A single rainfall totaling 1.63 inches on July 9 fell in a period of less than one hour, with a water loss of 95.6 per cent. On the other hand, a rainfall on June 14, 1927, on the same plat, totaling 2.1 inches and falling over a period of 14 hours, showed a loss of only 1.37 per cent by run-off. Heavy, washing rains are characteristic of the semi-humid region.

The physical condition of the land is apparently an important factor in the water loss. A plat left bare and unspaded on March 13 lost 40.73 per cent of a rainfall amounting to .93 inch, as against no water loss from plats that were spaded 5 inches in February. There seems to be a considerable difference in the loss from lands under different crops, as, for example, buffalo grass has been found, as elsewhere, very efficient. The results indicate that milo is more efficient than cotton early in the season, depending probably on the extent to which the crop is taking water from the soil.

On two comparable plats, one having level terraces and the other having the rows running with the slope, which slope is about one foot in 100 feet, a yield of 952 pounds of seed cotton was obtained from the terraced plat as compared to a yield of 669 pounds from the unterraced plat, or an increase of 42 per cent over the unterraced plat. All of these results, though preliminary, are indicative of results of tremendous importance.

PLANT PATHOLOGY AND PHYSIOLOGY

Projects

1. Root Rot Investigations; Adams and State funds; J. J. Taubenhaus, leader.
   Sub-project A: Root Rot Study at Substation No. 9.
   Sub-project B: Control of Texas Root Rot of Alfalfa and Related Crops.
2. Tomato Diseases; Hatch and State funds; J. J. Taubenhaus, leader.
3. Diseases of Cabbage, Lettuce, and Spinach in Texas and Their Control; Hatch and State funds; J. J. Taubenhaus, leader.
4. A Study of Pecan Scab and Related Diseases of the Pecan; Hatch, State, and Cooperative (with School of Agriculture) funds; J. J. Taubenhaus and G. W. Adriance, leaders.

5. A Study of Diseases of Perishable Crops in Transit and Methods of Control; cooperative funds from Western Weighing and Inspection Bureau; J. J. Taubenhaus, leader.

6. Preliminary Studies with Sulphur or Strong Bordeaux Causing What is Termed "Burning" of Foliage in Cucurbits; State and cooperative (with Freeport Sulphur Company) funds; J. J. Taubenhaus and W. H. Friend, leaders.

Cotton Root Rot

The work under this project during the year has consisted of:

(1) **Infection Experiments.**—Under this, three methods were tried: (a) by infected roots from freshly wilted plants; (b) by pure cultures of the fungus, and (c) by spores of the fungus. So far the infected roots of freshly wilted plants have given the best results, infection reaching from 70 to 80 per cent. The pure cultures have as yet shown very little promise. The problem now is to determine whether the aging of the fungus in culture affects its virulence. No infection has so far been produced by spores. Temperature apparently plays no part in infection. Cotton plants were grown in containers and maintained under constant temperatures of 70, 80, 90, 100, 110, and 120 degrees Fahrenheit. While the soil temperature seems to have a decided influence on the growth of the cotton plant, its effect on infection is not outstanding. Incidentally, it was found that the optimum soil temperature under greenhouse conditions was 90 to 100 degrees Fahrenheit, while minimum growth and development took place at a soil temperature of 110 to 120 degrees Fahrenheit.

(2) **Spore Spots in Central Texas.**—For the first time we have found spore spots of the root rot fungus in Central Texas. This was found on a farm not very far from the Station by Mr. B. F. Dana, Plant Pathologist, located at Substation No. 5, Temple, Texas, and more recently on the Temple Station grounds on a piece of land that was devoted to various varieties of cotton and artificially inoculated at various times with infected cotton roots and kept moist through slow weekly irrigations. Work along this line seems to indicate that moisture, in the soil or in the atmosphere, is apparently the only factor in favoring the development of spore spots under field conditions. Flooding seems to be harmful to the production of spore spots. On the other hand, gradual, slow, persistent irrigation for a period of three to eight weeks seems to favor the development of spore spots. The fact that dry-farming is the prevalent type of farming in Central Texas and the further fact that the spore spots are abundantly found in South and West Texas under irrigation conditions would confirm the belief that moisture is the one important factor in spore spot formation.

Spore Germination: In our attempt to study the function of the spores, it was necessary to determine under what conditions or treat-

ments germination would be best obtained. The spores were subjected to various methods of treatment by hydrochloric acid, temperatures varying from 0 to 150 degrees Fahrenheit, soap solution, etherization, effect of light or darkness, varying concentrations of sucrose, maltose, lactose, and plant juices of cotton, and sweet potatoes and Irish potatoes. Preliminary work so far has shown that small percentages of germination were obtained at 110 to 130 degrees Fahrenheit. A small percentage of germination was also obtained by subjecting spores to a weak soapsuds solution.

Resistant Varieties of Cotton: Considerable work is being carried on this year in an attempt to determine the possibility of developing resistant strains or varieties of cotton. This work is conducted at the Temple Station, and numerous varieties are being tested through artificial inoculation as to their resistance to root rot. A cotton claimed to be resistant to root rot was received from South America and planted together with the other varieties and artificially inoculated. So far the work tends to show that no variety of cotton is resistant, and future work will determine whether or not there is resistance in individual strains.

Root Rot Control as Determined by Soil Reaction: Considerable work is being carried both under field conditions and in containers on the possible effect of controlling root rot by attempting to change the soil reaction. Unfortunately, this work was started very late in the season and a dry summer has affected the results, which are of little or no value so far. It seems that if changing the soil reaction is to be attained, soil treatments, whether with sulphur or other agencies, should be carried out in the fall and should be allowed to have plenty of time to act.

Tomato Diseases

No research work was done during the year on this project.

Diseases of Cabbage, Lettuce, and Spinach

No research work was done during the year on this project.

Pecan Diseases

No research work was done during the year on this project.

Diseases of Perishable Crops in Transit

The work under this project, the funds for which are furnished by the Western Weighing and Inspection Bureau, consists of gathering data on the cause of various diseases of fresh fruits and vegetables as they occur in transit. Diseased specimens are received from the railroads of the State and the diseases are carefully diagnosed and recorded. It is thought that in time enough data will be collected to use in publishing a bulletin on the subject.

Sulphur Projects

The work under these projects includes the project on "Preliminary Studies with Sulphur or Strong Bordeaux Causing What is Termed 'Burning' of Foliage in Cucurbits" and the cooperative project with the Division of Entomology on "Sulphur and Sulphur Compounds as Fungicides and Insecticides," and the following four phases of the projects have been considered during the year:

(a) The effect of sulphur and sulphur compounds on Powdery Mildew control.

(b) Determination of the cause of burning of sulphur on cantaloupe leaves.

(c) The effect of sulphur on the control of damping off.

(d) Sulphur as a fungicide against smuts.

(a) Various sulphur dusts were used on mildew of roses and crepe-myrtles. Sulphur was found to be effective in controlling mildew as long as the sulphur dust is present on the leaves. As soon, however, as the sulphur is washed off by rain new infections reappear within two to five days. Sodium thiosulphate when used at the rate of .5 to 1 per cent gave negative results in the control of powdery mildew, and a 1 per cent solution or stronger caused serious burning. We find that with the exception of plants belonging to the cucurbit family (squashes and cantaloupes, which are readily susceptible to sulphur burning) sulphur dusts can be effectively used in the control of powdery mildew on a large number of crops, including trucks, ornamentals, shrubs, and trees.

(b) The work under this section was more or less inactive during the year. However, numerous stages of burned cantaloupe leaves were imbedded, sectioned, and stained, and morphological and physiological studies will be made of these sections to determine just what happens to the tissue as a result of the sulphur burning. An attempt was made to determine whether or not it would be possible to add various compounds to the sulphur with a view of minimizing or preventing sulphur burning of cantaloupe leaves. Twenty-six formulas were used. It was found that none of the mixtures used with the sulphur were effective in preventing burning. The cause of sulphur burn and methods of control is still an important problem which is yet to be solved.

(c) Much work was carried out on determining the possible effect of sulphur on the control of damping off caused by *Sclerotium rolfsii*, Pythium, Rhizoctonia, and Fusarium. The soil used in this connection was collected at College Station on the grounds of the Research Administration Building, and was found to vary in pH from 7.7 to 5.8. It was found that *Sclerotium rolfsii* is a highly acid-loving organism. The application of 10,000 pounds of sulphur to the acre actually increased the acidity of the soil to a pH reading of 2.4 and yet such a condition did not very much affect the growth of *Sclerotium rolfsii* fungus. It was found that in pure cultures the fungus would grow within a pH range of 1.25; hence there appears to be very little hope in the use of sulphur in controlling *Sclerotium rolfsii* in acid soils. Likewise, our

work further shows that with the same type of soil sulphur offered very little promise in the control of damping off caused by Pythium, Rhizoctonia, and Fusarium. Amounts of sulphur as high as 30,000 pounds to the acre have been used and the high acidity produced by it did not very much affect the organism causing damping off. We find that the fungi of damping off thrive under a pH range in the soil as follows: Pythium, 2.0-5.8; Rhizoctonia, 2.9-7.4; Fusarium, 5.0-7.7. One point of interest to be emphasized is that applications of sulphur naphthalene when used as high as 30,000 pounds to the acre did not produce any change in the pH reading of the soil, as obtained by Gillespie's method. This indicates that further work will have to be done to find out whether or not sulphur naphthalene could be used as a promising soil fungicide because of the fact that it does not change the pH value of the soil when worked into it.

(d) Preliminary tests were made to determine whether or not sulphur could be used as a possible fungicide against covered or stinking smut of wheat and kernel smut of sorghum. The results obtained this year are unsatisfactory and need to be repeated.

Plant Disease Survey

This Division has continued to gather data on the prevalence of plant disease epidemics in the State, and has sent monthly reports to the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C. At the end of the year a complete report is made and also a summary representing the important plant diseases found by this Division or as reported by various interests in the State. These data are being compiled and at some future time will be presented as a publication in connection with much data on hand on soil-temperature studies.

FARM AND RANCH ECONOMICS

Projects

1. A Study of Ranch Organization, Methods and Practices and Costs of Range Livestock Production in the Edwards Plateau Region of Texas; in cooperation with the Bureaus of Agricultural Economics and Animal Industry, U. S. Department of Agriculture; State, Purnell, and cooperative funds; L. P. Gabbard, G. S. Klemmedson, and V. V. Parr, leaders.

2. A Study of Farm Organization, Methods and Practices, and Costs of Production of Farm Products in A Typical Blackland Cotton Farming Area of Texas; in cooperation with the Bureau of Agricultural Economics; Purnell, State, and cooperative funds; L. P. Gabbard and J. B. Hutson, leaders.

3. Factors Influencing the Marketing of Winter Vegetables in the Lower Rio Grande Valley; Purnell and State funds; G. L. Crawford, leader.

4. Local Cotton Marketing Study; Purnell and State funds; L. P. Gabbard and G. L. Crawford, leaders.

5. Range Vegetation of the Edwards Plateau; State funds; V. L. Cory, leader.

6. Study of the Carrying Capacity of the Pastures of the Ranch Experiment Station in Sutton-Edwards Counties; State and local funds; B. Youngblood, L. P. Gabbard, V. L. Cory, and E. W. Thomas, leaders.

7. Activities of Livestock on the Range; State funds; V. L. Cory, leader.

8. A Study of Costs and Methods of Range Livestock Production and Ranch Organization in the Northwestern Range Area of Texas; in cooperation with Bureaus of Agricultural Economics and Animal Industry, U. S. Department of Agriculture; L. P. Gabbard (Texas Station); G. S. Klemmedson (Bureau of Agricultural Economics); and V. V. Parr (Bureau of Animal Industry), leaders.

A Study of Ranch Organization, Methods and Practices and Costs of Range Livestock Production in the Edwards Plateau Region of Texas

This is a cooperative project in which the Bureau of Agricultural Economics and the Bureau of Animal Industry are cooperating with the Texas Agricultural Experiment Station. The ultimate aim of this project is to suggest possibilities for increased efficiency in the organization and management of the ranch as a productive unit. To do this it is necessary to determine the physical requirements in land, labor, productive livestock, feed, and equipment, and their relation to the results obtained. In so far as possible, ranching practices will be studied in relation both to physical requirements and results obtained. For example, one would want to know what relation kidding by hand has to the per cent of the kid crop, and the relation of the per cent of kid crop to the income derived from the goat enterprise. The records for the years, 1925 and 1926, have been tabulated. Twenty-three men cooperated in 1925 and twenty-seven in 1926. This project is planned to cover a period of five or six years. In the meantime, the aim is to return as much information as possible to the ranchmen cooperating. For the years 1925 and 1926, the following statements have been returned to each cooperator for his ranch:

(1) Distribution of investment.

(2) Operator's earning statement.

(3) Cost of production statements for mohair and wool and for calves.

(4) Factor sheet. This sheet enables the ranchman to compare himself with his neighbor cooperators in such factors as calf, kid, and lamb crop, rate of stocking, death loss, costs, and per cent earned on investment, and so forth.

A Study of Farm Organization, Methods, and Practices, and costs of Production of Farm Products in a Typical Blackland Cotton-Farming Area of Texas

This is a cooperative project between the Texas Agricultural Experiment Station and the Bureau of Agricultural Economics, United States Department of Agriculture. The object of this study is to determine the amount of the different factors of production (in physical quantities) used and their relation to the output for each enterprise and to the output of the farm as a unit, with the ultimate aim of increasing the efficiency of the farm. The present plans are to close out this project January 1, 1928, at which time three years' work will have been completed. The detailed information secured, together with survey, census, and experimental data, are to be used as a basis for setting up more profitable systems of farming for the region represented in the study. The detailed data for the years 1925 and 1926, have been tabulated and partially summarized. Each cooperator has been furnished with the following:

(1) A blueprint map of his farm.
(2) A summary of his inventory.
(3) An operator's earning statement.
(4) Cost of production statements for cotton, corn, and oats.
(5) A factor sheet.

Marketing of Winter Vegetables in the Lower Rio Grande Valley

This study covered the irrigated section of the Lower Rio Grande Valley of Texas. The object of the study was to determine the kind and amount of vegetables produced, cost and method of harvesting, grading, packaging, packing, processing, storing, transporting, and the agencies rendering these services. A schedule was used in securing the information on the marketing of vegetables for the season of 1925-26. Personal visits were made to 215 vegetable growers and 15 vegetable shippers. These vegetable growers were growing 20 different varieties of vegetables, cabbage being the leading vegetable. The services rendered in gathering and hauling ranged from $2.74 per ton on cabbage to 27 cents per hamper of carrots. The distance hauled from the farm to the shipping sheds ranged from three to four miles. Three of the principal consuming centers for the Lower Rio Grande Valley vegetables are St. Louis, Chicago, and Pittsburg. St. Louis received over 1400 cars of Texas vegetables for the season of 1925-26. The rate on cabbage from the Valley to St. Louis is $23.47 per ton and in proportion to other points.

Local Cotton Marketing Study

The object of this study has been to determine the degree to which the local markets distinguish between the different grades and staples of cotton, and to what extent the prices paid in central markets are reflected in prices paid upon the local markets.

Men have been located at Robstown, Henderson, Hillsboro, and Lubbock for three months of the year during the active cotton-harvesting season. These men gathered 2,513 cotton samples, with the history of each sample written on a card and wrapped with the sample. These samples were concentrated at the Main Station at College Station, where they were graded and stapled by the United States Government grader and stapler. The number of samples gathered at the different local points for the season of 1926-27 was as follows: Hillsboro, 231 bales; Henderson, 542 bales; Robstown, 408 bales; and Lubbock, 521 bales.

This study is proceeding this year as outlined for last year. In addition to the four points, samples are being secured at Waco from the McLennan County Cotton Association and the Sunshine Cotton Seed Association at McKinney, Collin County.

Range Vegetation of the Edwards Plateau

This project has for its chief object a study of the character and economic importance of native vegetation of the Edwards Plateau region for grazing purposes. During the year, typical areas of about eleven acres in each of the six main pastures of the Ranch Experiment Station have been selected for mapping and detail study. Each of the designated areas is to be studied over a period of at least two years with the view of obtaining the following information:

1. To identify, classify, and catalogue the different species, and to estimate the percentage of the particular species to the total forage.
2. To determine the production periods of the different species. The task here is to indicate when the different forage plants are available and significant for purposes of grazing range livestock.
3. To determine the different types of vegetation and the relative extent of each. These types are designated as open grass lands, oaks, brush, saccahuiste, and so forth.
4. To collect samples of the important types of vegetation for chemical analysis.

The data have not been fully developed, but the work will be prosecuted vigorously during the year 1927-28. A considerable amount of identification work for the Station ranch and the Plateau in general will be done. Also maps have been made of definite areas in pasture G and these have been studied in detail chiefly for testing the method to be used in the study of areas selected in each of the six pastures of the ranch.

Carrying Capacity of Pastures of the Ranch Experiment Station

The object of this project is to check the application of a proposed carrying capacity of 70 units per section in the proportion of 31 units of cattle, 26 units of sheep, and 13 units of goats. After securing actual weights on the mother cows on the Station ranch, a 900-pound cow has been used as the unit instead of a 750-pound cow. This unit reduces the

units per section to 52 in the proportion of 23 units of cattle, 19 units of sheep, and 10 units of goats.

The table given below shows the number of carrying-capacity units consumed by the different classes of livestock for the years 1924, 1925, and 1926, compared with the standard being checked. It will readily be seen that all of the years are above the proposed standard and especially the year of 1924. Grazing conditions for the year 1924 were exceptionally good and the Station ranch was heavily stocked. The range was very poor during the winter and spring of 1925. Such conditions make it necessary to do a great deal of supplemental feeding and are generally followed by heavy death losses and relatively low calf, lamb, and kid crops.

Carrying-Capacity Units by Types of Livestock for the Six Main Pastures of the Station Ranch, 1924, 1925 and 1926.

	Standards*	1924	1925	1926
Cattle	23	34.62	26.44	28.03
Sheep	19	25.85	21.41	24.47
Goats	10	13.92	10.85	13.19
Total	52	74.39	58.70	65.69

*The standard originally used was 70 units per section—31 cattle, 26 sheep, and 13 goats. The unit of measure used was 5,591 pounds of dry matter, the amount necessary to maintain a mother cow weighing 675 pounds at the beginning of the year, 750 pounds at the end of the year, averaging 712½ pounds, thus providing for 75 pounds of gain (Texas Station Bulletin No. 297). Four weighings per year show an average weight of slightly above 900 pounds for mother cows on the Station ranch. For this reason a 900-pound mother cow has been used as the unit and the standard becomes 52 instead of 70 units per section.

Activities of Livestock on the Range

A manuscript reporting work done under this project was submitted to the Director on May 3, 1927, for approval and publication as a Texas Station bulletin. This manuscript will be published as Texas Station Bulletin No. 367, "Activities of Livestock on the Range." In this manuscript are summarized the observations taken monthly over a period of three years.

In this study three types of range livestock have been observed: cattle, sheep, and goats. Their behavior has been grouped under a number of activities, such as grazing, browsing, miscellaneous feeding, idling, ruminating, traveling, and so forth. Both the absolute and relative amounts of time devoted by the animal to each of these activities are shown. For example, cattle spend approximately 10 per cent of their day in travel, sheep 13 per cent, and goats 19 per cent; while 56, 50, and 46 per cent, respectively, of their time is taken up by feeding activities. It is observed that three-fourths of the total feeding of cattle and sheep is devoted to grazing, while goats devote only one-third of their feeding period to grazing. The preferences of the different types of animals for the various kinds of range vegetation are also shown.

A Study of Costs and Methods of Range Livestock Production and Ranch Organization in the Northwestern Range Area of Texas

The field work on this project was completed at the close of the calendar year 1925. It includes financial and management data taken from a representative number of ranchmen in the Seymour and Benjamin area of Texas, beginning in 1920 and ending with the fiscal year 1925, covering a period of six years. The data have been tabulated and are being worked into manuscript form by Mr. V. V. Parr, representative for both the Bureau of Agricultural Economics and the Bureau of Animal Industry. The detailed data secured, supplemented by any other available data, will be used as a basis for recommending certain changes in the organization and operation of ranches in the grazing region of which the ranches studied are typical.

RURAL HOME RESEARCH

Project

1. The Adequacy of the Diet of Texas School Children; Purnell fund; Jessie Whitacre, leader.

The Adequacy of the Diet of Texas School Children

This project is planned to proceed along two distinct lines: (1) a general, qualitative study of the character of the diet of a rather large number of representative school children in each of six well differentiated agricultural regions of Texas, and (2) an intensive, quantitative study within each region of a smaller number of children who differ in age and degree of physical well-being.

In the general study, the pupils are asked to keep a written record on forms provided for them of all the food which they eat for eight consecutive days at two seasons of the year; also, they check a list of foods so as to show their appetities for each food and their eating habits. The qualitative adequacy of the meals recorded by each child is to be judged by a score card which embodies the current standards for feeding of school children. The records will also be examined to discover any correlation between general character of the diet and two health indices, namely, height-weight-age status and quality of teeth as determined by a dentist's examination.

With the cooperation of six school systems and 94 teachers, dietary records and health data have been secured from over 2,500 pupils. Hidalgo County, in the Rio Grande Valley region, and Brazos County have been covered in the first season's survey. Jefferson County, in the Gulf Coastal region, has been half covered. The accumulated records represent chiefly native white Americans and Mexicans and smaller numbers of Italians and Bohemians. Additional records to be secured will include negroes. Approximately one-fourth of the diet records have been scored. No analysis or interpretation of the data has as yet been made.

The intensive phase of the project awaits time and additional personnel for its execution. The plan is to weigh the food eaten for four consecutive days by each of the children selected; to take samples of the foods for which, later, calorie values will be determined by means of the oxy-calorimeter, and with the cooperation of the Division of Chemistry, to have these food samples analyzed for nitrogen, calcium, and phosphorus. These data will be interpreted for each child in conjunction with his state of well being, which is to be determined, if possible, with the aid of a physician's cooperation.

SOIL SURVEY

Detailed soil survey work was carried on in cooperation with the United States Department of Agriculture in five counties of the State during the past fiscal year, about 1800 square miles having been mapped in that time. Victoria, Willacy, and Navarro Counties, being projects carried over from the previous year, were completed and the reports of these areas, together with maps, were presented for preparation for publication. Field work was continued in Van Zandt County but that area remains unfinished as work has been carried on intermittently. A survey of Midland County was begun at the request of numerous citizens and considerable of the area was covered. This county lies on the southern Staked Plains mainly and there is a considerable extension of farming, much of the ranch land being subdivided and sold to farmers. Much of this county lies in a region where the extension of cotton- and grain-sorghum farming is developing rapidly, and more information relating to the soils of that county will doubtless give valuable data for a large portion of the South Plains, where much land is being opened up for farming.

A reconnoissance soil survey of the Trans-Pecos region was started in the spring of 1927. This large area comprising slightly more than one-tenth of the State of Texas is an important ranching section of the State, cattle being grazed over much of the region, while in certain districts sheep and goats are raised in considerable numbers. While this area lies well in the sub-humid region with relatively low rainfall, there is a great diversity of native vegetation: much of it is suited to the grazing of range stock, while in certain sections the grasses are especially valuable for livestock. A soil survey, even though of such a general nature as a reconnoissance will provide information which will aid in the study of range problems. In addition to the regular soil survey work a range botanist from the Experiment Station is detailed to work with the soil surveyors in studying the character and distribution of the native vegetation and in observing the relations of such plants to the soils. This work will doubtless provide a foundation on which to base investigations of such problems as the loco weed and other poisonous plants on the range; the matter of stock distribution to eliminate over-grazing; the extension of sheep and goat raising on certain types of land where thus far this branch of stock raising is limited;

and in the study of many other range problems. Certain sections of the Trans-Pecos region are occupied by large areas of splendid agricultural soils which are utilized only by means of irrigation from springs, wells, storm-water reservoirs and streams. Some of the soils are successfully used in this way and probably the soil survey will indicate the location of other areas which can also be utilized in such a way.

During the year three regular soil surveyors have been employed by the Experiment Station and an equal number has been maintained in the State by the Bureau of Soils.

Some special work was done by soil surveyors during the year outside of the regular mapping of soils. This included the selection of suitable soil types for use in carrying on cotton root rot investigations by the Division of Plant Pathology and Physiology; cooperating with the Extension Service in studying drainage and the salt-accumulation problem in Northwest Texas; securing information on pecan soils for the Experiment Station; and in collecting samples of soil for the Division of Chemistry of the Experiment Station in surveyed areas. Also very detailed soil surveys of Substations Nos. 1 and 3, at Beeville and Angleton, respectively, were made for the Division of Agronomy of the Experiment Station, thus completing detailed surveys for every substation in the State.

During the year, soil survey reports and maps were published and issued to the public of the following counties: Coleman County, Reeves County, and Cameron County.

BOTANY

The activities of the Division of Botany have continued to be directed toward the collection of herbarium specimens representing the flora of the State. To this end, a number of trips were made to several sections and the specimens collected have been identified, mounted, and stored for use in connection with agricultural research in the various sections of the State.

During the fiscal year, the Chief of the Division made a trip to the State forests of East Texas for the purpose of making a survey of the vegetation in those forests. A trip also was made to Substation No. 3, Angleton, to identify and report on the grasses introduced and under test at that Station. An examination of the various species of grasses under trial there indicates that there are several among them which may prove of very great importance as pasture or hay plants in large sections of the State if given a better chance than by cultivation in drills. Some grasses like the Centiped grass, *Eromochloa opbiuroides,* and the St. Augustine grass, *Stenotaphrum secandatum,* should also be tested on the soils of East Texas because in their native habitat they form valuable pastures on poor, sandy, or clayey soils, and they protect such soils from erosion.

Based on these two trips, two articles were published during the year: one, entitled "Grasses of the Coast Country," was published in Farm

and Ranch, and the other, "The Distribution Limits of the Long-leaf Pine," was published in the Southern Pacific Farm News.

In collaboration with V. L. Cory, who has been assigned the duty of collecting the specimens, identification of the flora of the Trans-Pecos region is being made in connection with the reconnoissance soil survey which is being made of that region at the present time.

SWINE HUSBANDRY

Projects

1. Cottonseed Meal for Maintaining, Growing, and Fattening Hogs; State and local funds; Fred Hale, leader.
2. A Study of the Effect of Adding Various Minerals to Rations for Fattening Hogs; Hatch and sales fund; Fred Hale, leader.

Cottonseed Meal for Maintaining, Growing, and Fattening Hogs

This year's work seems to indicate that pigs will eat too much cottonseed meal when it is fed free-choice in a self-feeder, especially in a dry lot. One lot of pigs fed cottonseed meal free-choice in a self-feeder on oat pasture made good gains and showed no toxic effects from eating the cottonseed meal. It is not recommended that one feed cottonseed meal free-choice in a self-feeder, however, for when pasture conditions are not favorable the pigs might eat too much meal.

In other tests various amounts of cottonseed meal were fed in the ration, ranging from no cottonseed meal and 10 per cent tankage to 15 per cent cottonseed meal and no tankage.

These tests seem to indicate that better results are obtained with fattening pigs when not over 9 per cent cottonseed meal is included in the ration, the ration being composed of ground milo, 87 pounds; tankage, 4 pounds; and cottonseed meal, 9 pounds. Salt and limestone were also added to this ration.

Our previous work indicated that the ration may contain 15 per cent cottonseed meal for fattening pigs in dry lot for a period of 120 days, starting with 50-pound pigs and hand-feeding twice daily. Our work this year shows that it is not safe to include over 12 per cent cottonseed meal in the ration when the ration is mixed and self-fed in dry lot in a self-feeder. Two pigs died from cottonseed meal poison where 15 per cent cottonseed meal was included in the ration and fed in a self-feeder, the pigs being put on test with an initial weight of 57 pounds and the test lasting 120 days.

The five brood sows receiving a ration containing 15 per cent cottonseed meal seem to stay in as good condition and produce as many pigs as do the tankage-fed sows, but the pigs do not grow off quite as rapidly as do the tankage-fed pigs. We have never had any toxic condition with brood sows on pasture where they received a ration containing 15 per cent cottonseed meal, and the sows farrow as large litters as do the tankage-fed sows.

A Study of the Effect of Adding Various Minerals to Rations for Fattening Hogs

No work was done this year with minerals for hogs.

DAIRY HUSBANDRY

Projects

1. Constructive Breeding of Dairy Cattle; State and local and co-operative (with the School of Agriculture) funds; G. P. Grout and J. L. Lush, leaders.
2. Feeding Value of Cottonseed Hulls as a Roughage for Growing Dairy Heifers; dairy sales fund; J. L. Lush and Fred Hale, leaders.
3. The Use of Cottonseed Meal and Hulls as a Ration for Lactating Cows; dairy sales fund; J. L. Lush and Fred Hale, leaders.

Constructive Breeding of Dairy Cattle

The work under this project was continued during the year. All the records made by the cows at Substation No. 10, College Station, have been corrected for age and to a standard 305-day lactation period. The average mature equivalent 305-day record in this herd, including all lactation up to January 1, 1927, was 5562 pounds of milk and 284 pounds of fat. The variation, however, was large—the coefficient of variability was 23 per cent—and fully one-fourth of the cows exceeded 6840 pounds of milk and 350 pounds of fat. This indicates a decided lack of uniformity in the breeding of the herd as it has existed in the past. Some of these records were made by cows which have since been culled out and sold because of poor production. The cows still living in the herd on January 1, 1927, had records which averaged 5855 pounds of milk and 305 pounds of fat. This included two heifers with very poor records for their first lactation period. These heifers will be culled at the close of their second lactation unless the second records are very much better than their first ones. It is the plan of this project to get at least two lactation records on each heifer, regardless of her breeding or type. Thus the figures show that some slight progress has been made toward increasing the average production of the herd, but such progress has been much slower than was hoped. Future breeding is being directed toward moderately close breeding among the descendants of our best cows. The present herd bulls are half-brothers both out of the very best cow which this herd has yet included, but each of them sired by a different bull. They are being mated so as to line-breed to the good cows of the herd with avoidance of intensifying the blood of any inferior or ordinary cow or bull. The few grade cows in the herd are being used to test out extremely close mating, such as sire and daughter. In general, mating closer than half-brother by half-sister is not used in the purebred herd. A certain amount of barrenness and abortions in the herd has kept the numbers down so that culling for

low production could not be carried out at as high a standard as would have been desirable.

Feeding Value of Cottonseed Hulls as a Roughage for Growing Heifers

This project was first organized during this year and is planned to test whether cottonseed hulls as the sole dry roughage for growing heifers produce any good or bad effects which would not be expected on the basis of the known chemical composition and physical characteristics of cottonseed hulls. Bermuda hay is being fed to the control group. A large number of weights, measurements, and descriptions have been recorded in the nine months since the project started, but no analysis of these data has yet been made.

The Use of Cottonseed Meal and Hulls as a Ration for Lactating Cows

This project has been organized for only nine months and hence has not proceeded far enough to warrant definite conclusions. All cows receive salt and ground limestone and pasture and silage whenever the latter two are available. Cottonseed meal as the sole concentrate has had a tendency to be too laxative for best results, but so far milk production and weight changes have not shown very much difference in the feeding value of cottonseed meal as compared to a balanced grain ration. Doubtless the fact that pasture is included in both rations tends to equalize differences which might exist between the concentrate portion of the rations. This would also be true on nearly all farms in this State as nearly all dairy cows in Texas have access to at least a small amount of pasture during a large part of the year.

Value of Rice By-Products as a Feed for Dairy Cows

The results of three double-reversal feeding tests have been analyzed and published as Texas Station Bulletin No. 352, "Rice Bran as a Feed for Dairy Cows," which is available for free distribution. The most important findings in connection with these tests are as follows: some of the cows seemed to dislike the grain rations containing rice bran even when they contained as little as 36 per cent of rice bran. When good green pasture was available all cows refused a larger proportion of the rice bran ration than of the ration which did not contain rice bran. In spite of its lower palatability, rice bran proved to be a very useful feed for dairy cows. Even a heavy ration of rice bran produced no bad effects on the flavor of the milk. The use of rice bran in the dairy ration is recommended when it can be purchased for less than four-fifths as much per ton as milo chops or corn chops. If the rice bran is to constitute more than a third of the grain ration, the dairyman should watch his cows very closely to find out which ones dislike rice bran and feed those cows a ration containing a smaller proportion of rice bran. On account of the readiness with which rice bran becomes rancid, the buyer should take care to purchase rice bran as fresh from the mills as

possible. On account of the seasonal nature of the rice-milling industry, fresh rice bran is easiest to obtain between early September and March or early April.

Work under this project has been discontinued.

POULTRY HUSBANDRY

Projects

1. Breeding as Affecting Egg Production; State and local funds; R. M. Sherwood, leader.
2. Comparison of the Feeding Value of Protein from Vegetable Sources With Protein from Animal Sources for Laying Hens; State and local funds; R. M. Sherwood, leader.
3. Comparison of Various Feeds for Young Chickens; State and local funds; R. M. Sherwood, leader.
4. Studies of Variation in Hatching Quality of Eggs; State and local funds; R. M. Sherwood, leader.

Breeding as Affecting Egg Production

This study embraces a test of the ability of different cockerels to transmit high egg-production tendencies to their progeny. Up to the present time, the study has included only the female progeny. The progeny from six cockerels were trap-nested with a range in average egg production of the various cockerels from 130.3 $\pm$ 5.1 to 180.6 $\pm$ 4.9. The standard deviation ranged from 52.2 $\pm$ 6.9 to 16 $\pm$ 3.5 eggs. The per cent of daughters laying over 180 eggs ranged from 12.5 per cent to 60 per cent and the per cent laying less than 100 eggs ranged from 22.6 per cent to 00.0 per cent. The cockerels that prove to be good breeders are used to mate high-bred females in the Station flock.

Another part of this project is a study of the improvement in egg-production of a strain of White Rock fowls by the introduction of Barred Rocks, and later by eliminating the color factor. A small pen of $F—_1$ birds was mated this year and the eggs pedigree-hatched. All white pullets will be trap-nested. The breeding pens of White Rocks were mated to Barred Rock cockerels the past spring and their pullets will be trap-nested and the better ones continued in the test.

In another part of this study an analysis of data on the relation of body characters to egg production was made and the following zero order correlation coefficients and partial correlation coefficients with annual egg production have been calculated:

	Letters Designated in Regression Equation	Zero Order Coefficients With Egg Production		Partial Correlation Coefficients With Egg Production (100 Hens)
		(96 Hens)	(100 Hens)	
Weight	A	+.180	—.182	—.284
Color shanks	B	—.484	—.458	—.290
Color beak	C	—.463	—.311	+.224
Handling quality	D	—.453	—.363	+.064
Thickness of pubic bone	E	—.441	—.261	+.104
Pliability of pubic bone	F	—.437	—.404	—.327
Width of pelvic arch	G	+.310	+.304	+.194
Capacity of pelvic arch	H	+.384	+.316	+.212
Moult	I	—.467	—.245	+.020
Length of back	K	+.199	+.177	+.083
Width of back	L	—.164	+.231	+.098
Depth in front	M	+.411	—.095	+.488
Length of sternum	N	+.044	+.105	—.176

Regression equation for data on 96 hens is:

$$\overline{X} = -.107\,A - 16.726\,B + 2.284\,C - 1.983\,D - 12.307\,E + 18.468\,F - .131\,G + 1.684\,H - 5.512\,I + 3.386\,K - 4.673\,L + 7.140\,M + .965\,N - 146.743$$

Regression equation for data on 100 hens is:

$$\overline{X} = -2.608\,A - 19.464\,B + 14.088\,C + 4.339\,D + 7.890\,E - 19.632\,F + 2.633\,G + 2.910\,H + .284\,I + .913\,K + 1.320\,L + 10.346\,M - 3.503\,N - 221.467$$

The coefficients in the above table and the regression equations do not agree in all cases. In fact, one regression equation will not fit the data for the other flock. This, together with the difference in signs between the zero order correlation coefficients and the signs of the characters in the regression equation, leads us to believe that there were not enough classes for some of the characters and possibly the observations of some of the characters are duplicates of other characters. For example, probably color of shanks and color of beak are two observations of the same physiological conditions that causes a fading color.

Comparison of the Value of Protein from Vegetable Sources with Protein from Animal Sources When Fed to Laying Hens

This project has been carried on actively since 1919. During the past year, nine different rations containing varying amounts of cottonseed meal were tested. These tests showed that cottonseed meal was a useful feed for economical production and that the eggs showed no marked discoloring when fresh. However, when these eggs were placed in storage for several months, the eggs from hens receiving large quantities of cottonseed meal did not stand up. Further experiments are being conducted to determine how much cottonseed meal may be fed without injuring the keeping quality of the eggs. An attempt is being made to learn what it is in the meal that is most injurious to the eggs. Cottonseed oil was added to meat-scrap rations and next year fat-free cottonseed meal will be tested. Other studies will be made to try to learn what is causing this trouble.

Comparison of Various Feeds for Young Chickens

The work under this project was carried on during the year but the test was not completed. The test comprised a study of various milks as compared with no milk in an attempt to limit losses of chicks and the study of the rate of growth under these conditions.

Studies of Variation in Hatching Quality of Eggs

The work under this project was continued during the year. Data were secured from 3944 eggs from 128 individual hens and from 43,107 eggs from different flocks. The eggs from the individual hens ranged in hatchability from 0.0 per cent to 100 per cent. The seven different flocks ranged from 44.9 per cent to 71.9 per cent hatchability of the total eggs set. The average hatch of the 43,107 eggs set this year was 65.7 per cent as compared to 69.8 per cent the last year and 65.3 per cent the previous year. Seasonal conditions, flock management, handling conditions, breed of fowls, and individuality are factors which cause differences of hatchability of eggs under like conditions.

FEED CONTROL SERVICE

A thorough system of inspection has been maintained during the past year. Inspectors of the Feed Control Service have continuously visited feed manufacturers, feed dealers, and a considerable number of consumers in order to secure official samples for analysis, weigh packages to prevent the selling of short-weight feeds, and to detect any other violations of the law. Each inspector files at the office at College Station a weekly route sheet, which is subject to revision by the Chief, and mails a report of his activities daily. Inspectors have traveled 65,167 miles in the performance of their official duties this year. Many trips have been made from the office at College Station for the purpose of making special investigations.

During the past year inspectors of the Feed Control Service have secured 1502 samples which were subjected to chemical analysis and microscopical examination. In addition to these, 197 registration samples and 54 special samples were analyzed, making a total of 1753 samples analyzed during the year. Cooperation with the Bureau of Chemistry, United States Department of Agriculture, was continued during the year.

The system of reporting the results of inspection continues the same as in the past years. Results of the inspection of feeds are reported to the manufacturers, dealers, and consumers in order that all parties interested may know to what extent the provisions of the feed law are being complied with. When the analysis of a sample shows the shipment to be misbranded or adulterated, the retailer is notified at once and advised to remove it from sale until the matter has been satisfactorily adjusted. In this respect all retailers and dealers have given their hearty cooperation.

During the year dealers have been advised to remove from sale 318 shipments of feed manufactured by 199 different firms, or a total of 1,632,310 pounds. This amount of feed was being offered for sale in violation of some provision of the feed law of this State. Untagged shipments were properly labeled, improperly tagged shipments were relabeled, and the sales of feed below guarantee were in practically all cases adjusted by the manufacturer paying a refund to dealers and consumers when the deficiency was sufficient to warrant such action. Fifteen complaints were filed, seven of which are still pending. Six cases were settled on payment of fines; three were dismissed, and one defendant was tried and found not guilty.

A representative of the Division has attended conventions of the Association of Official Agricultural Chemists of North America, the Association of Feed Control Officials of the United States, the Association of Food, Feed and Drug Officials of the South Central States, and the Texas Cottonseed Crushers' Association. In the Association of Food, Feed, and Drug Officials of the South Central States, the Chief of the Division was a member of the Committee on Food and Fertilizers and Chairman of the Executive Committee. In the Association of Feed Control Officials of the United States, he was President and a member of the Committee on Definitions and Standards for Wheat Mill Feeds, and a member ex-officio of the Executive Committee. The Chief of the Division is now Chairman of the Committee on Alfalfa Products in the Association of Feed Control Officials.

As in previous years, two semi-annual conferences of feed inspectors were held, both of these being held at College Station, one in September, 1926, and the other in April, 1926. These conferences serve also as a school of instruction for inspectors who have been in the service only a short time.

MAIN STATION FARM

The Main Station Farm is the main field laboratory for the Division of Agronomy, and keeps a separate set of records and is otherwise operated similarly to the substations. It is located on the lands of the Agricultural and Mechanical College of Texas, at College Station, Brazos County, the lands used being adjacent to and west of the Southern Pacific and Missouri Pacific Railway tracks, in latitude 31 degrees 39 minutes north and longitude 26 degrees 36 minutes west, with an elevation of 308 feet above sea level.

The Main Station Farm comprises 127 acres of land, 52 acres of which are used for experimental purposes and the remaining acreage for Station buildings, pastures, roadways, and increase areas for seed production.

Ginning Studies: A study of the ginning of cotton in relation to the market and spinning value of the lint is one of the projects being conducted on the Main Station Farm. This is made possible because of equipment consisting of a two-stand Murray Air-Blast Gin, operated

for experimental purposes in this study and for the additional purpose of ginning pure seed for farmers. This work includes studies of the effect of ginning on the quality and value of the lint. The question of ginning in its relation to grade and in relation to the ultimate spinning value of the lint has an economic importance which should be fully understood, just as questions affecting the growing of the crop in the field have an economic importance, and should be fully understood, so that the grower may not only produce a product of good quality and high ginning utility, but that this utility can be maintained throughout its preparation for market.

Rotations, Fertilizers and Soil Improvement: This work consists of rotations with corn, oats, cotton, and cowpeas in comparison with continuous cotton and continuous corn. Seven different fertilizer treatments are used on both rotated and non-rotated areas. These treatments are: superphosphate; superphosphate and cottonseed meal; superphosphate and manure; rock phosphate and manure; manure alone; and crop residues removed; and plats with no fertilizer treatment. The results with cotton in 1926 showed heavier yields from the non-rotated land, due to cutworm damage in the early growing season on the rotated lands. The average yield for a period of 13 years ranged from 166 to 197 pounds of lint cotton to the acre on the rotated land, as compared with a range from 153 to 192 pounds on the non-rotated land.

Rotated Corn averaged from one to three bushels of shelled corn to the acre more than non-rotated corn, and over a period of 13 years showed an average increase of seven bushels of shelled corn to the acre.

Some Additional Soil Fertility Studies which are part of rather comprehensive experiments with fertilizers in the eastern half of the State, were begun in 1927. In these studies a 12-4-4 fertilizer at the rate of 400 pounds per acre is used as a standard treatment, and each element,—nitrogen, phosphoric acid, and potash,—is varied in turn while the other two are kept constant. The 12-4-4 fertilizer is used also at the rate of 200, 400, 600, and 800 pounds per acre. The work is carried in a three-year rotation of cotton, corn, and oats, the oats being followed by cowpeas as a catch-crop for soil-improving purposes. Each treatment occurs four times on each crop. These studies should yield valuable information regarding the best fertilizers to use on these crops and soils within a few years.

Sulphur Studies: No increased yields have been noted in cotton and cowpeas from applications of 100 pounds and 200 pounds of sulphur to the acre.

The Variety Test of Cotton included 16 varieties in 1926. New Boykin made the highest yield, 310 pounds of lint per acre. It also made the highest average yield, 258 pounds, for the last four years. The results of the variety test over a period of years show that in general Mebane

or strains of Mebane (such as Mebane, Kasch, New Boykin, and Cliett), along with Truitt, Lone Star, Acala, and Rowden are good varieties of cotton for this part of Texas. The results of the variety test of cotton at the Main Station during the fifteen years, 1912-1926, inclusive, are being published in Bulletin 369, "Varieties of Cotton for East-Central Texas."

The Variety-date Test of Corn, embracing eleven varieties and three dates of planting has been conducted since 1918. In 1926 Johnson County White made the largest yield, 23 bushels per acre as an average of all dates of planting. For the eight-year period, however, Ferguson Yellow Dent made the highest average yield, 28 bushels per acre. From the date standpoint, the early planting gave the best yield in 1926, or 21.3 bushels per acre; the medium planting, 12.8 bushels; and the late planting, 16.6 bushels per acre. For the duration of the experiment the early planting made an average yield of 35.2 bushels, the medium planting 29.5 bushels, and the late planting 24.7 bushels per acre, as an average of all the varieties.

In the Test with Varieties of Oats, consisting of nine varieties, Red Rustproof (T. S. No. 1118) and Ferguson No. 77 made the highest yield, each producing 58.4 bushels per acre in 1926. For the nine-year period 1917-1926, excluding 1925, Texas strain of Red Rust-proof oats, T. S. No. 1415, made the highest average yield, 33.1 bushels per acre.

A rust nursery was conducted in cooperation with the United States Department of Agriculture, for the study of rusts affecting small grain.

Groit and Brabham cowpeas continue to be the outstanding varieties of cowpeas for both forage and seed yields, while Chinese Red is the earliest variety to mature and is a higher yielder of seed.

Project No. 221 of the Division of Entomology is being conducted in cooperation with this Station. This is a study of insect pests of corn while in storage, to determine the relative importance of the insect pests of stored corn; the rate of loss to the grain as a result of the presence of the insects; and to determine the most practicable fumigation or control measure.

AGRICULTURAL ENGINEERING

During the year, three projects relating to the field of agricultural engineering have been in progress through cooperation with the Department of Agricultural Engineering, School of Agriculture, Agricultural and Mechanical College of Texas. Project No. 211, "A Study of the Cotton Planter Dropping Device," has yielded up a considerable amount of data, which have been compiled and studied, after which it has been thought desirable to continue this work until at least data for another year or two are available. The present trend of planting cotton, particularly in the West, where conditions are more or less ideal for planting and obtaining the desired stand, show the importance of such a detail study of planting devices.

A second project dealing with agricultural engineering problems is

Project No. 209, "Run-off Water Losses in Relation to Crop Production," which project is carried in the Division of Agronomy and reported on in the Division of Agronomy report included herewith. This is an important problem involving many phases of agricultural engineering which have to do with conserving rainfall and reducing the amount of water turned into our streams.

Project No. 229, "Large Scale Cotton Production in Texas," carried under the Division of Farm and Ranch Economics, was a part of the work of the Division of Agricultural Engineering. The work under this project was completed during the year with the publication of Bulletin No. 362, "Large Scale Cotton Production in Texas."

A project entitled "Small Combine Harvesting of Grain Crops" is also a part of the work of this Division, in cooperation with the Division of Farm and Ranch Economics.

PUBLICATIONS

As in the previous year, the activities of the Division of Publications during the present year have consisted largely of supervising the work of the Publications Committee, through which committee all publications of the Station must pass before being finally submitted to the printer; the necessary work in editing and proof-reading. manuscripts; and, finally, the distribution of the printed publications to best advantage.

A total of 397,663 copies of Station publications were distributed during the year, including bulletins, circulars, and press bulletins, being a gain of 147,763 copies of the regular bulletins and circulars of the Station over the previous year. While there was a decided increase in the number of copies of publications sent out, the mailing list had decreased from 70,927 names at the close of last year to 69,402 names at the close of this year. This means an increase in the number of publications sent out on direct request from farmers and other citizens of the State.

Attention is called to the fact that the number of publications issued during the year has exceeded by six bulletins and one circular the output for the last fiscal year, there being a total for the present year of 20 bulletins, six circulars, and one annual report. The publications issued have contained agricultural information of a high order based on agricultural research done by the Texas Station and have been received with much favor by those in need of such information.

The following is a tabular statement of the 20 bulletins, six circulars, and one annual report issued during the fiscal year:

No.	Title	Number of Pages	Number Copies in Edition
	Total	948	428,000
Bulletin No.			
346	Commercial Fertilizers in 1925-26 and Their Use	60	8,000
347	Studies in the Biology of the Pecan Nut Case Bearer	71	10,000
348	Commercial Feeding Stuffs (September 1, 1925, to August 31, 1926)	133	8,500
349	Variation in Certain Lint Characters in a Cotton Plant and Its Progeny	23	6,000
350	Fertilizer Statistics for Texas	27	8,000
351	Short-Term Farm Credit in Texas	25	18,000
352	Rice Bran as a Feed for Dairy Cows	22	20,000
353	The Influence of Parentage, Nutrition, Temperature, and Crowding on Wing Production in Aphis Gossypi, Glover	19	6,000
354	Varieties of Cotton for the Gulf Coastal Plains of Texas	39	12,500
355	Relation of the Potash Removed by Crops to the Active, Total, Acid-soluble and Acid-insoluble Potash of the Soil	33	6,000
356	Control and Spring Emergence of the Cotton Flea Hopper	32	25,000
357	Effect of Potash Fertilizer on the Carrying Quality of Tomatoes	38	12,000
358	An Economic Study of the Dairy Industry in Texas	36	12,000
359	Hybrid Vigor in Sorghum	23	9,000
360	The Effect of Spacing and Time of Thinning on the Yield, Growth and Fruiting Characteristics of the Cotton Plant in 1925	38	6,000
361	The Work of the State Apicultural Research Laboratory, 1919 to 1926	16	10,000
362	Large-Scale Cotton Production in Texas	24	16,000
363	Sorgo Silage, Sorgo Fodder and Cottonseed Hulls as Roughages in Rations for Fattening Calves	36	20,000
364	Varieties of Cotton in Northwest Texas	59	16,000
365	Crop Rotation in the Blackland Region of Central Texas	21	12,000
Circular No.			
42	Feeding Chickens	8	15,000
43	Johnson Grass in Texas	15	18,000
44	Abstracts of Bulletins 328-346 and Circulars 32-42	18	75,000
45	Texas Agricultural Outlook for 1927	16	38,000
46	Legumes for Texas Beekeepers	12	10,000
47	Spraying for the Control of Fig Rust	8	11,000
	Annual Report, 39th (1925-26)	96	20,000

In addition to the research bulletins and circulars printed by the Station, the workers have prepared and submitted for publication in scientific journals and the press 26 contributions on various subjects coming within the field of their investigations. A list of these contributions follows, and copies of the publications can possibly be had from the publisher. The Station has no copies available.

1. More Education Needed in Meat Cuts; J. M. Jones, Chief, Division of Range Animal Husbandry; Special Meat Issue of the Farm and Ranch, Vol. 45, No. 46, page 4, November 13, 1926.
2. Avoid the Use of Ridgling Bucks; J. L. Lush, Animal Husbandman, Division of Range Animal Husbandry; Sheep and Goat Raisers' Magazine, Vol. 7, No. 2, pages 12 and 13, September, 1926.
3. Winter Management of the Farm Flock of Sheep; J. M. Jones, Chief, Division of Range Animal Husbandry; The Progressive Farmer, Vol. 41, No. 52, page 7, December 25, 1926.
4. How Much Accuracy is Gained by Weighing Cattle Three Days Instead of One at the Beginning and End of Feeding Experiments;

J. L. Lush, Animal Husbandman, Division of Range Animal Husbandry; read before the American Society of Animal Production, Chicago, Illinois, November 26-27, 1926; Proceedings of the American Society of Animal Production, pages 206-210, November, 1926.

5. Opportunities in Mohair Production; J. M. Jones, Chief, Division of Range Animal Husbandry; The Country Gentleman, Vol. XCII, No. 3, page 126, March, 1927.
6. Recent Events in Animal Husbandry Research; J. L. Lush, Animal Husbandman, Division of Range Animal Husbandry; The Cattleman, Vol. 13, No. 9, pages 27-29, February, 1927.
7. Better Balanced Farming and Greater Volume of Business is Needed for Texas Farms; L. P. Gabbard, Chief, Division of Farm and Ranch Economics; read before the Texas Hardware and Implement Association, Dallas, Texas, January 18, 1927.
8. Management of the Angora Goat Flock at Kidding Time; J. M. Jones, Chief, Division of Range Animal Husbandry; The Country Gentleman, Vol. XCII, No. 4, page 76, April, 1927.
9. The Case of the Three-Quarter Blood; J. L. Lush, Animal Husbandman, Division of Range Animal Husbandry; the Journal of Heredity, Vol. 18, No. 8, pages 351-367, August, 1927.
10. What the Agricultural Experiment Station Means to the Range Stockman; A. B. Conner, Acting Director; The Cattleman, Vol. XIII, No. 12, pages 19-25, May, 1927.
11. Efficient Range Utilization; J. M. Jones, Chief, Division of Range Animal Husbandry; The Cattleman, Vol. XIII, No. 10, page 95, March, 1927.
12. How Animals Fatten; J. L. Lush, Animal Husbandman, Division of Range Animal Husbandry; The Cattleman, Vol. XIII, No. 10, pages 89-93, March, 1927.
13. Direct and Indirect Causes of Decay to Fresh Fruits and Vegetables in Storage and Transit; J. J. Taubenhaus, Chief, Division of Plant Pathology and Physiology; read before the Shippers' Advisory Board, San Antonio, Texas, February 4, 1927.
14. What Range Animals Feed Upon—Grazing; V. L. Cory, Grazing Research Botanist; The Cattleman, Vol. XIV, No. 3, pages 13-16, August, 1927.
15. What Range Animals Feed Upon—Browsing; V. L. Cory, Grazing Research Botanist; The Cattleman, Vol. XIV, No. 4, pages 15-19, September, 1927.
16. Outline of a Course of Lectures on the Decay of Fresh Fruits and Vegetables in Storage and Transit; J. J. Taubenhaus, Chief, Division of Plant Pathology and Physiology; course of lectures and demonstrations given to shippers and carriers at the A. and M. College of Texas, March 7 and 8, 1927.
17. The Time and Rate of Blooming in Rice; H. H. Laude, formerly Superintendent, Texas Substation No. 4, Beaumont, and R. H. Stansel, Superintendent, Texas Substation No. 3, Angleton; Journal of the American Society of Agronomy, Vol. 19, No. 9, pages 781-787, September, 1927.
18. Ventilation; H. B. Parks, Apiculturist, State Apicultural Research Laboratory; The Beekeepers' Item, Vol. 11, No. 9, pages 289, 304, 305, September, 1927.
19. The Miscellaneous Feeding of Range Livestock; V. L. Cory, Grazing Research Botanist; The Cattleman, Vol. XIV, No. 5, pages 23-25, October, 1927.
20. The Supplementary Feeding of Range Livestock; V. L. Cory, Grazing Research Botanist; The Cattleman, Vol. XIV, No. 6, pages 24-26, November, 1927.

21. Selecting Representative Wool Samples; J. M. Jones, Chief, Division of Range Animal Husbandry, and J. L. Lush, Animal Husbandman; Sheep and Goat Raisers' Magazine, Vol. 7, No. 12, pages 31-33, July, 1927.
22. The Agricultural Experiment Station and the Sheep and Goat Industries; A. B. Conner, Acting Director; Sheep and Goat Raisers' Magazine, Vol. 7, No. 12, pages 35-39, July, 1927.
23. Preparation for Wintering in the South; H. B. Parks, Apiculturist, State Apicultural Research Laboratory; Beecause, Vol. 6, No. 4, pages 1 and 6, August, 1927.
24. A History of Honey Flow; H. B. Parks, Apiculturist, State Apicultural Research Laboratory; the American Honey Producer, Vol. 1, No. 7, pages 90, 91, 92, October, 1927.
25. What is Economy; H. B. Parks, Apiculturist, State Apicultural Research Laboratory; Beecause. In Press.

In addition to the list of contributions, the workers have prepared a number of popular articles for publication in the agricultural press and for delivery over the radio, on subjects of timely interest to farmers and to the citizenship in general.

SUBSTATIONS

The diversity of climatic and soil conditions in Texas provides well defined agricultural regions within which the problems can best be studied through substations or field laboratories where the work can be carried out under the conditions existing where the problem is encountered. This diversity of conditions and the largeness of the State have been responsible in the main for the establishment by the State of a system of experiment stations—fifteen in number—for the study of specific problems peculiar to these different agricultural regions.

Texas maintains the largest system of experiment stations of any State in the Union and necessarily so because of the fact that Texas comprises an area as large as five average-sized states and with a greater diversity of climatic and soil conditions than exists within the boundaries of any other State; hence the problems of these several large agricultural regions justify the expenditure of moneys for the study of specific problems in the particular areas involved. The substations have become more and more important as they were able to undertake some of the more fundamental and widely applicable problems of the territory served and, accordingly, these substations are rendering a service of inestimable value in the development of the agriculture of the several agricultural regions. They can render even a greater service and will render such service as they are able to take up other problems of wide application and importance. These substations are regional stations and not local stations in any sense of the word. Many of them already have under way important regional studies; for example, the Spur Station is conducting a series of investigations in connection with the study of water and soil losses and means of curtailing these losses comparable to the best research conducted in any State. The problem is one of such importance as to command the interest and support of the entire region where the results apply. Likewise, Substation No. 5,

located near Temple in the Houston Black Clay soils, is undertaking in a comprehensive way to solve the root rot problem, as in this soil region the cotton root rot disease finds conditions suitable for the most destructive work. Accordingly, the conditions and facilities here afford a point of attack for the study of a problem which causes an annual loss to the farmers of Texas of millions of dollars, and any reasonable amount of money put into the study to provide facilities and conditions for work is money well spent, provided the work is systematically done and the results accumulated. Similarly, Substation No. 14, located near Sonora, is attacking the problems confronting the sheep and goat industries of the Edwards Plateau region—a region as large as an average-sized state. The problems in the Rio Grande Valley are important problems applying to a region of great possibilities when the horticultural and agricultural wealth is fully developed and safeguarded by known facts relating to agriculture and horticulture in that region.

In a similar way, the several substations are serving different regions and although in some cases the support is too limited to enable them to undertake and systematically study and solve some of the more important regional problems, they are undertaking each year as conditions permit, to more nearly drive at the important problems of the region they serve and in this way develop their usefulness and value.

There is no denying the fact that these substations through research can serve the several agricultural regions in a comprehensive way and in a way which affords a sound and permanent basis upon which the agriculture of the region must be developed. They are in many cases under-manned and under-equipped. Notwithstanding this fact, the several substations are doing creditable work and will in time receive the necessary support for functioning in their respective regions in the most effective way to meet the demands for information placed upon them.

Substation No. 1, Beeville

Substation No. 1 is located 5.5 miles northeast of Beeville, Bee County, and is adjacent to the Galveston, Harrisburg & San Antonio Railway; latitude 28 degrees north and longitude 97 degrees west; and with an elevation of 240 feet above sea level. The average rainfall recorded over a period of 31 years was 28.80 inches. The farm comprises 151.5 acres, of which 104 are in cultivation, 28 in pasture, 3.5 acres in farmstead, 6 acres in roads and ditches, and 10 acres in wasteland. This station is located in an agricultural region which can best be designated as interior black prairie lands, principally Victoria and Goliad series of soils.

The early work of this station was principally with citrus fruits and vegetables and the results obtained have contributed largely to the subsequent development of citrus fruit and vegetable growing in Southwest Texas and formed a basis for the development of these phases of agriculture in the Lower Rio Grande Valley and in the Winter Garden district. In recent years the region served by this station has developed more into

a general farming area, and the principal lines of work to which attention is being given at the present time include both agronomy and horticulture. In the work with field crops, particular emphasis is being placed on cotton, broom corn, grain and forage sorghums, corn and legumes.

Cotton: In a comparison of 19 varieties of cotton the past year, those having a staple of one to one and one-sixteenth inches, and of medium lint percentage and medium size of boll continue to be the most profitable varieties for the region served by this station. During the past four years New Boykin has given the highest yield of lint, 266 pounds to the acre. Other Mebane strains have produced better yields of lint than either the big-bolled varieties or those varieties producing staple longer than 1 1-16 inches. Lightning Express during this same four-year period has given higher yields of lint than any other long-staple varieties.

Broom Corn: Experiments in comparing field-cured with shed-cured broom corn have shown that shed-curing materially increases the quality and value of the brush. Six varieties of broom corn were grown the past year. Considering both yield and quality, the Miller Dwarf proved to be the best adapted and most profitable variety to grow, yielding at the rate of 450 pounds of brush to the acre. Black Spanish, Standard, produced 542 pounds of brush to the acre, but the brush was not of desirable quality for use in the manufacture of brooms. The Scarborough Dwarf has given a brush of high quality, commanding a slightly better market price, but it is doubtful that the increased price received will offset lower yields produced by this variety. As an average for the past three years, Scarborough Dwarf has yielded 310 pounds of brush to the acre, as compared with 450 pounds produced by the Miller Dwarf.

Grain Sorghums: Experiments with grain sorghums indicate that Texas Blackhul kafir, a new variety originated and distributed by the Texas Station, and Dwarf hegari may be recommended for general planting throughout this section. Date of planting experiments have shown that Texas Blackhul kafir should be planted from March 10 to April 20, and that this kafir has outyielded all other varieties for early and medium plantings. Dwarf hegari should not be planted before April 10, and gives better results when planted in May. For the later plantings this variety has given better results than any other grain sorghum. Pure seed of both Texas Blackhul kafir and Dwarf hegari have been increased on this station during the past year for distribution to farmers in this region. Sumac sorgo sown broadcast for hay produced the highest yields when planted at the rate of 60 pounds of seed to the acre. The best yields of Sudan grass were obtained from a seeding rate of 20 pounds to the acre. Sumac sorgo has proved to be the best adapted variety and when planted broadcast for hay has given higher yields than Sudan grass.

Corn Breeding: A new project in corn breeding, which is a part of a more extensive project in corn breeding in Texas, was started at this station during the past year. This project has for its object the further improvement of the best varieties of corn adapted to this region through the development of inbred strains of these varieties, which later will be used for the production of high-yielding cross-bred strains. Thomas corn, a strain particularly adapted to the region, and improved and maintained by the station, Surcropper, and Yellow Dent, are the three varieties from which inbred strains are being produced.

Legumes: The introduction and testing of legumes for the purpose of finding those best adapted to this section constitute an important part of the work. *Melilotus indica* yellow annual sweet clover made an excellent growth the past season and promises to make a good legume cover crop. Subterranean clover was killed out by hot weather this season and seems to be of little promise. Bur clover continues to be the outstanding winter cover crop for orchards and also makes an excellent winter pasture for growing in Bermuda and other pastures.

Angleton Grass: Attempts to sod a pasture with Angleton grass by planting the roots was unsuccessful this year because of the dry season, but the pasture which was already established continues to thrive and make an excellent growth.

Fertilizers: Fertilizer experiments during the past year included eighteen different formulas and showed that the fertilizers high in phosphoric acid and nitrogen give the greatest increase in yields when applied to either cotton or corn. Potash continues to show little increase and sulphur, when applied to cotton as a fertilizer, has given no increase in yield.

Fruits: The horticultural work at this station at the present time is largely along the line of propagating more hardy strains of Satsuma oranges and the testing out of other fruits. Old trees of round oranges and grapefruit which were damaged by a freeze in 1925 are recovering, made a good growth during the current year, and should come into bearing next year. The Meyer lemon came into bearing this season and produced fruit of good size and quality. This fruit seems to be somewhat resistant to cold and is promising for this region, where other lemons will not thrive.

Substation No. 2, Troup

Substation No. 2, Troup, is located one mile northeast of Troup, Smith County, latitude 32 degrees north and longitude 95 degrees west; with an elevation of 483.7 feet above sea level. The average annual rainfall over a period of 22 years was 42.61 inches. The station comprises 152.6 acres of land and is located in the central part of the region known as the East Texas Timber Belt. Practically all of the soil on

the station devoted to experiments belongs to the various phases of the Susquehanna series.

This station, located in an important fruit and vegetable district of East Texas, was established for the purpose of solving the important problems concerned with fruit, truck, vegetable, and general-crop farming in this area. The experiments conducted have included the testing and improvement of promising fruits, nuts, vegetables, berries, and grapes, as well as the more important farm crops. A major line of investigation is concerned with the building up and maintaining of soil fertility through the use of crop rotation, commercial fertilizers, and legumes.

Tomato Fertilizer: In the tomato fertilizer work this year the plats receiving 450 pounds of acid phosphate and 160 pounds of nitrate of soda to the acre produced the highest average yield of marketable tomatoes. The second highest yield was obtained from plats receiving 300 pounds of acid phosphate, 300 pounds of cottonseed meal, and 45 pounds of muriate of potash. As in former years, the results indicate that phosphoric acid and nitrogen are both limiting factors in tomato production. Potash in varying amounts did not make consistent increases in yields.

Peach Fertilizers: The fertilizer work with peaches, in which the Elberta variety was used, was continued, but no results were obtained, as the trees again failed to set a crop of fruit. A normal crop of fruit buds was formed, but following a prolonged period of blooming, which continued from the middle of February to the first of April, the fruit all dropped.

A Pecan Orchard, consisting of twenty-five varieties planted in 1904 and 1907, is on a poorly drained phase of Susquehanna fine sandy loam, which may be responsible in a large measure for the negative results obtained from this test. The results have not been entirely satisfactory, but they have shown quite conclusively that pecans are not adapted to all types of soil in East Texas, and that anyone who contemplates planting a pecan orchard should exercise the same precaution in selecting a location that he would in selecting a site for a peach orchard.

Cotton Varieties: In the cotton variety test, using 17 varieties, Half-and-Half made the highest yield of lint cotton; namely, 385 pounds to the acre. Truitt ranked second with 342 pounds; Mebane 804 third with 326 pounds; Harper fourth with 325 pounds, and New Boykin fifth with 324 pounds. Half-and-Half was the only variety in the test which produced a staple less than seven-eighths of an inch in length.

Show Better Adapted Varieties Over a Period of Several Years: Early-planted corn this year averaged 33 bushels to the acre; medium-planted, 37 bushels; and late-planted, 36 bushels. Over a period of nine years, the early-planted corn has averaged slightly more in yield

than the medium- or late-planted. This year the Bloody Butcher variety produced the highest yield; Oklahoma White Wonder, second; Hasting's Prolific, third; Fentress Strawberry, fourth; and Surcropper, fifth. Over a period of nine years Surcropper ranks first, while Ferguson's Yellow Dent ranks second in yield.

Sulphur as Fertilizer: When used as a fertilizer for cowpeas, sulphur at the rate of 250 pounds or 500 pounds to the acre did not increase the yield of seed. In a two-year average, 1925 and 1926, the yields were: no treatment, 7.2 bushels to the acre; 250 pounds of sulphur, 7.2 bushels; 500 pounds of sulphur, 7.7 bushels.

Soil Improvement Investigations, the object of which is to determine the fertilizer requirements of the soil for corn and cotton, were started in the spring of 1927. Soil-improvement work in connection with a Nitrate Fellowship established by the Educational Bureau, Chilean Nitrate of Soda, was also begun this year.

Substation No. 3, Angleton

Substation No. 3 is located 3.1 miles northeast of Angleton, Brazoria County, adjacent to the St. L., B. & M. Railway; latitude 29 degrees north, and longitude 94 degrees west; with an elevation of 23 feet above sea level. The average rainfall over a period of 13 years was 47.01 inches. The station comprises 159.3 acres of land, and is located in a region known as the Gulf Coast prairie, composed principally of the Lake Charles and Edna series of soils.

The principal purpose of this station is to aid in the development of the agriculture on the flat coastal prairie soils. The land is generally flat and has comparatively poor drainage, but is fertile and productive of a variety of field and horticultural crops. In recent years a great deal of interest in commercial fig growing has been shown in this section, and this station is endeavoring to determine the best varieties of figs adapted to the region and the most successful and profitable practices in the management of fig orchards, the best fertilizers to use, methods of pruning, and fig-rust control.

Forage Crops: The region is especially well adapted to forage crops, and these should perhaps remain the principal crops of this section. Many new forage crops, particularly grasses for the improvement of pasture lands and for use as hay crops, have been tested out at this station. Angleton grass, a species of *Andropogon,* introduced and distributed from this station, has been found to be one of the most valuable forage crops for the region, and its popularity and use in this section are greatly increasing. Small quantities of this grass have been distributed throughout Texas and also to other states. Forage-crop testing, consisting chiefly of the trial of new and promising grasses for this region, is one of the important lines of work of this station. During the present year a number of the most promising species have been trans-

planted out of nursery rows into larger beds for further observation and a few have been transplanted into larger blocks for hay yields and pasture experiments.

Cotton: Kasch, Lone Star, Acala, and Rowden varieties of cotton, which have been grown continuously for the past ten years at this station, have yielded on the average at the rate of 279, 257, 240, and 207 pounds of lint to the acre, respectively. During the past two years the best yields have been obtained from Delfos, Mebane 804, New Boykin, and Kasch. Delfos, a new longer staple variety, but having rather small bolls, gave the highest yield both years. This variety is promising as a staple cotton for the Gulf Coast prairies. Bulletin 354 has been published dealing with cotton varieties. Some new work in cotton improvement, using a strain of Mebane, T. S. No. 804, has been inaugurated at this station, with the view of developing a high-yielding strain of cotton for this region.

Corn: In a variety and date of planting test of corn covering the past five years, Surcropper, Brazos White, Hastings Prolific, and Tuxpan were the best varieties in the order named. From the standpoint of date of planting corn in this region it was found that the yield of corn produced decreased as the date of planting was delayed. The early date of planting gave an increase of 5.6 bushels to the acre over the late planting. Corn breeding work at this station was extended during the past year to include more intensive work in the production of inbred strains of Surcropper and Tuxpan varieties, with a view of later determining the most desirable inbred strains for hybridization, this being a part of a more extensive project in corn breeding.

Figs: Figs are becoming an important commercial crop in this region. Ischia, Brunswick, Lemon, Magnolia, and Black California are varieties which have been found to do well at this station. Fertilizer experiments conducted with figs at this point during the past three years indicate that acid phosphate and potash seem to be about equal in value, both giving substantial increases in yield. There was no noticeable difference, however, in the time of maturity of the figs receiving different fertilizer treatments. Preliminary trials indicate that increased yields of figs may be obtained through the use of lime on soils of the type found on the station. Sulphur in any quantity seemed to be injurious to fig trees and reduced the yields. Fig rust, *Ureda ficia,* annually renders much of the fig crop of the Gulf Coast section unfit for market. Experiments conducted at this station and reported in Circular No. 47 on "Spraying for the Control of Fig Rust" have shown that fig trees should be sprayed with Bordeaux 5-5-50 as soon as the disease appears, which is usually about July 15, and that subsequent applications should be made often enough to protect new leaves and fruit until the last fruit is mature. This means spraying on an average of approximately every thirty days beginning July 15 and continuing until Sep-

tember 15. Bordeaux used as a dormant spray was ineffective in controlling fig rust. Pruning experiments with figs conducted here indicate that when the trees are pruned lightly, moderately, or unpruned, a much earlier crop is produced than when the trees are heavily pruned, as is the common practice among fig growers. Trees pruned lightly, however, mature their crop in a very short time, which is a serious disadvantage when the figs are to be marketed at preserving plants.

Other Fruits: A number of other fruits, including Satsuma oranges, Meyer lemon, pears, apples, and pecans are being tested out on this station. Satsuma oranges and the Meyer lemon set a good crop of fruit this year. A number of varieties of pears and apples are being grown for the purpose of testing their resistance to blight.

Substation No. 4, Beaumont

Substation No. 4 is located six miles west of Beaumont on the S. P. and B. S. L. & W. railroads; latitude 30 degrees north, and longitude 94 degrees west; elevation 26 to 30 feet above sea level. The rainfall over a period of 34 years was 50.03 inches. The station comprises 100 acres of land located in the eastern part of the Gulf Coastal region, principally on Crowley and Lake Charles soil series.

This is an irrigated station, established in the beginning chiefly as a rise station. It is also one of the main purposes of this station to develop suitable grain and forage crops for use in connection with rice farming, and to develop the fruit and vegetable possibilities of the section.

Rice Varieties: The principal work of this Station is the improvement of varieties and strains of rice, together with that of finding the best farming practices and fertilizers to use in connection with the growing of this crop. Texas Fortuna, a high-yielding strain of long grain rice, which stands up well in the field, has been developed and distributed by this station. During the past year approximately 1,000 pounds of this strain were placed on a commercial rice farm for further increase and distribution. An effort is also being made to further improve the milling quality of this variety. Selections are also being made from the Lady Wright variety, which is a popular long-grain rice, in order to obtain further improvement in the yield and uniformity of this variety. *Bulao luzon,* T. S. No. 5315, is a promising short-grain variety of rice of very uniform quality and high yield.

Fertilizer Experiments with Rice have been conducted here since 1915, and the results point definitely to the fact that an application of 100 pounds of sulphate of ammonia to the acre is the most profitable treatment used. The addition of acid phosphate has not given an increase in yield, and increasing the amount of sulphate of ammonia apparently does not increase the yield in proportion. This fertilizer seems to be particularly effective and results in the largest percentage of increase

where rice is grown continuously on the same land. A potash fertilizer has recently been included in this experiment. It has been found that the application of fertilizer to the rice crop approximately six weeks after planting will, on the average, give slightly larger increases in yield, but these increases are not of sufficient significance to offset the cost of applying after planting. Intertillage of rice land for the purpose of controlling weed growth has been found to be a valuable practice and results in increased yields.

Corn: Variety and date of planting tests of corn indicate that Tuxpan is the most profitable variety to grow in this section. Corn culture here should perhaps be practiced to only a limited extent on account of the uncertainty of the yield, wet weather and root worms being the principal factors depressing corn yields. During the past two seasons, however, the cane moth borer has attacked the corn crops and resulted in material damage. The best results in growing corn here seem to be from planting the Tuxpan variety on well prepared soil about May 10, so as to escape as nearly as possible damage from the root worms. For the past three years, Tuxpan has produced an average yield of 21.12 bushels to the acre, in comparison with 13.35 bushels to the acre produced by Hastings Prolific, the next highest-yielding variety.

Cotton: Results with cotton at this Station indicate that the two most important factors in growing this crop are proper drainage and a favorable season for harvesting the crop. Results here show that good yields of cotton may be expected during a favorable year. For the past two years Acala, Lightning Express, and Truitt have produced the highest average yields of 359, 357, and 345 pounds of lint to the acre, respectively.

Figs: The most promising horticultural crops for this section are figs and some of the hardy citrus fruits. The principal problems of the fig industry, which is being rather rapidly expanded in this section, are: determining the best varieties to grow, the best pruning practices, and methods of controlling the fig rust. Spraying experiments conducted for the control of fig rust indicate that the use of Bordeaux 5-5-50 as soon as the disease appears and repeated often enough to cover the growth of new leaves gives good protection from this disease. In a normal season this means that spraying will begin approximately July 15 and be continued every thirty days until September 15. Results with fig varieties indicate that the Magnolia and the Brunswick are the highest yielding varieties. Magnolia seems to be better adapted and the more profitable variety to grow, inasmuch as it stands handling better than the Brunswick. Several methods of pruning figs are being tried out. Results during the past year indicate that the earliest fruit is obtained where little pruning is practiced, but that the earliest yields and best quality of fruit are obtained where heavy pruning is practiced.

Citrus Fruits: The Meyer lemon promises to be a valuable fruit for this region and seems to be equally as resistant to cold as Satsuma oranges. This lemon produced a very satisfactory crop of fruit the third year after planting. A number of varieties of oranges and several varieties of grapefruit have been planted in an experimental way, but have not yet reached the bearing age.

Substation No. 5, Temple

Substation No. 5 is located four and one-half miles southwest of Temple and four miles northeast of Belton and adjoins the Temple-Belton highway. It is located at latitude 31 degrees north and longitude 97 degrees west, and has an elevation of 740 feet above sea level. The station consists of 96 acres, comprising 37 acres of cultivated land, four acres of roadways, and 55 acres of pasture and waste land. The station is located in the Blackland region of Central Texas. The average annual rainfall over a period of fourteen years is 35.36 inches.

The principal work of this station is concerned with the production of cotton. One of the contributions of this station has been the development and distribution of Belton cotton, a strain of Rowden. The cotton-breeding work is concerned largely with the collection of data for determining the value of different characters in relation to production of quality and quantity. This information is urgently needed in connection with the development of superior strains of cotton.

Other agronomic studies include the breeding of strains of cotton that will be resistant to root rot, soil-fertility investigations, and the development and distribution of superior strains of such crops as corn, oats, wheat, and sorghum, which are not affected by the cotton root rot disease.

Efforts to Breed Resistant Strains: The breeding of strains of cotton that are resistant to root rot is receiving a great deal of attention. In this study the plants are produced in such a way as to subject them to the maximum condition causing root rot. A collection and test of many of the species of the genus *Gossypium* is under way, and plant importations are being made from all parts of the world. Any species showing immunity or resistance will be used as the basis of hybridization and selection for the establishment of a commercial variety.

Crop Rotations: The soil-fertility studies include rotations, clean culture, application of various fertilizers and soil disinfectants, and cultural methods. Results of far-reaching importance to the Blacklands have been obtained by this station from crop-rotation studies. Crop rotation, when utilized in conjunction with clean culture to eliminate weed carriers of root rot, has been found to markedly reduce the amount of the disease and result in greatly increased yields. A plot of land which has been continuously in cotton for eleven years has been found to have an average annual root-rot infection of 39.7 per cent, with an average acre yield of 142 pounds of lint cotton, while the cotton, in

a cotton, guar, corn, and wheat rotation has been found to be only 4.8 per cent killed, and has yielded 285 pounds of lint cotton to the acre. These rotation results are treated in detail in Bulletin No. 365, "Crop Rotation in the Blacklands Region of Central Texas," which is now available to those interested. It has been found that rotation without the elimination of weed carriers is of little value in the control of root rot. Guar is the only leguminous crop that has been found to be resistant to root rot. The station is engaged in selection work, with the view of increasing its yielding power to the place where it will be a profitable forage crop.

A great many different fertilizers and soil disinfectants are being tested for the control of the cotton root rot disease. The control of root rot by this method would be of great practical importance to the nurserymen, horticulturists, and cotton growers.

Various cultural methods for the control of the cotton root rot disease are being investigated. It has been found that any method of cultivation that tends to eliminate the weed carriers of the root-rot fungus is of great value.

The study of the cause and control of cotton root rot is receiving the greater portion of the attention of this station. This work naturally falls under the heading of pathological and agronomic studies which are so closely related that a large part of the work is cooperative.

The Root Rot Organism: A detailed and thoroughly scientific study of the causal organism (*Phymatotrichum omnivorum*) is under way. The Temple Station is admirably situated for a study of this kind, as the fungus can be secured in all of its various stages. Particular emphasis is being given to the study of the spores which were found in Bell County for the first time this season. Inoculation studies have included the use of a number of different kinds of inoculum on the various soil types. An outstanding accomplishment of the pathologist has been the successful inoculation of cotton on bottom land that has never before had root rot. The disease when once started on this soil type seems to thrive and spread as it does on the typical Blackland uplands.

Various experiments are in progress to study the spread of the cotton root rot disease. Some very important information will be available on this point on the completion of this work.

Substation No. 6, Denton

Substation No. 6 is located five and one-half miles northwest of Denton, Denton County, on the Denton-Krum Highway, with a latitude of 33 degrees north and longitude 97 degrees west, and at an elevation of 650 feet above sea level. The station is located in an agricultural region which can be designated as Fort Worth prairie, which is for the most part black prairie soils. The soil is chiefly the San Saba and the Denton series. The average annual rainfall over a period of 14 years is 33.85 inches. The station comprises an area of 209.92 acres.

The primary object of this station is the improvement of small grains adapted to the wheat- and oats-growing region of North Texas and the development and improvement of other crops for this region. Plant introduction tests, with particular emphasis on legumes for use in crop rotation in connection with small grain farming, are an important part of the work of this station.

Wheat Breeding: The improvement in the yield and quality of the wheat crop is being accomplished through the selection of high-yielding pure lines. Through a series of preliminary experiments, the outstanding problems of small grain improvement have been pointed out and efforts are now being concentrated upon the isolation of the best pure lines of certain types of wheat adapted to the region. Hundreds of strains of wheat are tested annually for yield, earliness, rust resistance, strength of straw, and other characters. The most promising strains are then tested for their milling and baking qualities. Inferior strains are discarded and those of promise are increased and further tested in larger plats in comparison with each other and with the present standard varieties and are then increased for distribution to farmers when superior strains are found and proven. Denton wheat is a new variety developed through selection at this station and distributed to farmers for the first time in 1925. While the initial distribution of this new variety was necessarily small, over 500 acres of this new variety are now growing on the wheat farms of North Texas, and ample seed for other growers will soon be available. This variety has proved to be a high-yielding wheat, combining rust resistance and good milling and baking qualities.

Oat Improvement of a similar nature to the wheat work is under way and this station distributed last year a new strain of Red Rust-proof oats which was given the name of Nortex. It is estimated that more than 5,000 acres were planted to this variety in the fall of 1927. Nortex is a high-yielding pure-line oat, but lacks somewhat in winter hardiness, so that further selection work is under way in an endeavor to find still better adapted varieties. The Frazier oat, a strain of Fulghum, has been distributed by this station and widely accepted by the farmers in North Texas as the best oat for spring planting.

White Flowering Sweet Clover has been found to be the most promising legume for use either as a hay and pasture crop or in crop rotation. In rotation experiments it has been found that wheat and oats in rotation with sweet clover show marked increases in yield over small grain grown continuously on the same land. The yields of wheat and oats in rotation with legumes have been practically doubled over those secured from continuous cropping. A large number of strains and varieties of sweet clover are being tested out in an effort to find improved types of this legume better adapted to the region. The Austrian winter field pea and Hairy vetch seem to withstand the average winter freezes in this

region and are perhaps the two most promising legumes for winter cover crops to be turned under in the spring and fall with row crops.

General Crops: In addition to the work with small grains and legumes, other crops, such as corn, cotton, forage crops, and the sorghums are included in the experiments at this station. Half-and-Half, Sunshine, Truitt, and Harper were the four highest-yielding varieties of cotton included in the cotton variety experiments this year. Lone Star, Kasch, Mebane, and Rowden varieties for the past eight years have ranked in yield in the order named, producing on the average 195, 190, 189, and 162 pounds of lint to the acre, respectively.

A farm flock of sheep is maintained on this station for the purpose of utilizing the waste pasture land and for testing out the value of different crops for pasture, such as Sudan grass and sweet clover.

Substation No. 7, Spur

Substation No. 7, Spur, is located one mile west of Spur, Dickens County, latitude 33 degrees north, longitude 100 degrees west, and at an elevation of 2274 feet above sea level. The average annual rainfall over a period of 16 years was 22.06 inches. The station comprises 406.35 acres of land, 275 acres in cultivation and the rest in pasture.

This station is concerned with three principal lines of work: the development of profitable crop farming under conditions in this region, the utilization of crops grown in the region in the fattening of cattle and sheep, and a study of run-off water and soil erosion in relation to crop production. The study and development of crops and crop-farming practices was begun with the establishment of this station in 1909. Lamb-feeding-and-breeding work was added to the work of this station in 1914, and cattle feeding was begun in 1920. The project on run-off water losses was established during 1926. The experiments in crop and crop farming since 1909 have resulted in the development and distribution of two new strains of grain sorghum and the development and increase of a pure strain of cotton suited to this region, seed of which will be available in quantity for distribution to farmers within a short time. Over 300 varieties and strains of cotton and many strains and varieties of different feed crops, including hays, grasses, and legumes, have been tested with the view of obtaining more suitable crops for this section. Cultural methods, including different dates, rates, and methods of planting, seed-bed preparation, and cultural practices with both cotton and the sorghums have been studied and have resulted in the accumulation of much valuable information which has tended to reduce to a minimum the element of risk in farming in this region.

Weed Growth a Limiting Factor: Cultural experiments with both cotton and grain sorghums have shown that weed growth is decidedly the limiting factor in crop yields and, therefore, the elimination of weeds is the most important object to be accomplished through cultivation.

Early Planting of milo gave the highest yields of grain per acre this year. The medium date of planting produced larger heads, and this crop was more economical to harvest than the early planting and for this reason offset to a certain extent the advantage gained by the early planting through increased yield.

Red Kafir Leads in Yield: Eighteen varieties of grain sorghums were grown this year. Red kafir produced the highest yield, 60.12 bushels to the acre, and Dwarf Blackhul kafir ranked second. Milo and feterita are usually more profitable grain sorghums than kafir for this section, but the rainfall this year was particularly favorable to kafir.

Early Blooming Important: A study of the relation between the time of setting of blooms and the maturity of cotton this year showed that a large part of the cotton crop was set the first few days in July and the cotton blooming after this date formed a very small part of the total crop produced.

Nine-Inch Spacing Best: Cotton spaced nine inches apart in the row produced the highest yield this year. Over a period of years a spacing of from nine to twelve inches in thirty-six-inch rows has proved to be the most profitable practice.

Early-planted cotton, April 25, made the highest yield in 1926, due largely to an early freeze which seriously damaged the later plantings. The optimum time for planting cotton, as shown by an average over a period of years, is from April 25 to May 20. Earlier plantings usually produced poor stands.

Leading Varieties: Truitt, Durango, Lone Star, Lightning Express, and New Boykin were the high-yielding varieties of cotton this year, producing 589, 504, 486, 470, and 441 pounds of lint to the acre, respectively.

Increasing Selected Strains of Cotton: Splendid progress was made in cotton improvement work during the past year. Two hundred and twenty individual plant selections of Mebane 804 cotton were grown and increase blocks from progeny rows of the best selections made in 1919 and subsequent years were planted for further comparison. Ten of these selections were increased to acre plats and approximately twenty bushels of seed were produced from each of these selections this year. The best of these ten selections will be planted in larger increase blocks the coming year.

Alfalfa Profitable: Field experiments with alfalfa at this Station have shown that this is a valuable and profitable crop to grow in this region of the State, especially on the more favored valley lands or draws which receive the benefit of run-off water from adjacent areas or sub-irrigation water from below; the results being a marked increase in alfalfa planting and utilization on the farms of this region.

Rambouillets Good Feeders: It has been found in the sheep-breeding work at this station that lambs from Rambouillet ewes sired by Rambouillet rams are as valuable for the feed lot as lambs from Rambouillet ewes sired by mutton breeds of rams. Feeding and breeding work with Karakul sheep for a number of years has failed to show any probability of this breed's being profitable to Texas farmers or ranchmen.

Grain Sorghums Equal to Corn as Feed: Extensive studies of the feeding value of grain sorghums through feeding experiments with cattle and sheep have consistently shown these feeds to be as valuable as corn. The work of this Station in determining the comparative value of grain sorghums and corn has been a factor in the popularity and increased prices of grain sorghums on the primary markets and the further extension of their production in the western part of the State.

Farm Feeding: Recent feeding experiments at this Station indicate that lambs and calves may make profitable gains when fed sorghum hay and grain sorghum heads without going to the usual heavy expense of purchasing machinery and utilizing labor in the preparation of these feeds through grinding and chopping. While data from only one year's trial are available, it seems that if future tests corroborate these results, the feeding of cattle and sheep in a small way on the individual farms may prove to be one of the most profitable enterprises in conjunction with the average farm. Feeding experiments are also under way to determine the relative feeding value of the forage crops common to this region, including sweet sorghums, milo, kafir, feterita, and alfalfa.

Studies in Water Losses: The project on run-off water losses in relation to crop production has for its object the determination of the factors contributing to run-off water losses under semi-arid conditions as influenced by the physical condition of the land, the rapidity of precipitation, the slope of the land, and the value of terraces or other obstructions in preventing run-off. The project is also designed to study the effect of the prevention of run-off water losses on crop production. The factors contributing to run-off water losses are being studied on small control plats, from which the soil and water losses are caught and measured in concrete tanks placed at the lower end of the plats. The effect of preventing run-off water losses on crop production and the efficiency of terraces having different slopes or grades are being studied on ten field areas ranging from seven to eleven acres in size. Rapidity of rainfall is perhaps the most important factor affecting heavy losses of run-off water in the western part of the State. Heavy, washing rains are characteristic of this region, and it is the conservation of these downpours that seems to be of first importance. This year a total rainfall of 1.63 inches falling on June 9 in a period of less than one hour showed a loss of 95.6 per cent through run-off on a plat of cotton with a one per cent grade. On this same plat another rain on June 14 totaling 2.01, but falling over a period of 14 hours, had a run-off loss of only 1.37 per

cent of the total precipitation on the area. The effect of different crops and the stage of growth of the crop upon the run-off water losses during 1926 were found to be important factors. During this year a plat of Buffalo grass sod lost 12.6 per cent; a plat of milo 18.16 per cent; a plat of cotton 24.84 per cent, and a fallow plat 49.39 per cent of the total water that fell on these areas throughout the year.

Substation No. 8, Lubbock

Substation No. 8, Lubbock, is located three miles east of Lubbock, Lubbock County, latitude 33 degrees and 37 minutes north, longitude 101 degrees and 45 minutes west, at an elevation of 3106 feet above sea level. The average annual rainfall over a period of 16 years was 20.17 inches, with yearly extremes of 8.73 and 31.88 inches. The Station comprises 160 acres of land, 122 acres in cultivation and the remainder in pasture. The soil is of the Amarillo and Richfield fine sandy loam type, which is typical of a great portion of this section.

This Station is located in the High Plains region of Texas, being near the center of what is locally known as the South Plains. This region has until recent years been devoted largely to ranching, and in the transition from ranching to general farming this Station has been an important factor in the development and distribution of new crops adapted to the region and in determining the most successful agricultural practices in the preparation of the soil, planting, and cultivation of the crops grown. Since this Station is located in a more or less recently developed agricultural section of the State, it has had unusual opportunities in doing pioneer work toward the development of the region and in ascertaining facts and information upon which to base sound and constructive agricultural development. The principal objectives of this Station are: the introduction, breeding, and improvement of the grain and forage sorghums, which have been found to be the basic agricultural crops for the region; the breeding and improvement of varieties of cotton adapted to high altitude and limited moisture conditions; the determination of the best method of soil management and crop treatment in the region; and the collection of reliable information on fruit and truck crops, shade and ornamental trees and shrubs, legumes and other crops and plants essential to a well rounded out agricultural program for the region. Another branch of the work at this Station is that of determining the value and efficiency of windmill irrigation as applied to the individual farm and its practicability in connection with irrigating a small orchard, garden, and other specialized crops, such as small areas of alfalfa for hogs and poultry.

Kafir and Milo Differ in Space Requirement: Results of ten years' work with planting kafir and milo at different rates show conclusively that the space requirement in the row for these two crops for maximum production is distinctly different. The best yields on the average of kafir have been obtained from spacing the plants 3 to 6 inches apart

in 3-foot rows, whereas the highest yields of milo have been obtained from a row space of 24 to 36 inches. The difference in the spacing requirement between these two plants is found in the fact that milo has the ability to sucker and, therefore, adjust itself to the moisture and plant food available, when given a wide space in the row, more effectively than the grower can estimate these qualities of the soil at planting time. Kafir, not having the inherent ability to produce suckers compensating for a thin stand, when spaced widely in the row is not able to fully utilize the moisture and plant nutrients or the productive power of the soil.

Close Spacing Favored for Sweet Sorghum: Results of seeding rates with forage sorghums over a period of eleven years, where the Sumac variety was used, show that there is not a marked difference in yield between the 3-inch and the 18-inch space between plants in rows 36 inches wide, but that the yields are slightly in favor of planting this variety of sweet sorghum so as to have stalks from 3 to 6 inches apart in the row. Close spacing has shown a further advantage of producing a better quality of forage.

Best Adapted Grain Sorghums: In a comparison of a large number of different strains and varieties of grain sorghums since the establishment of this Station it has been found that Dwarf Yellow milo, Spur feterita, and Dwarf Blackhul kafir are the three dependable varieties adapted to this region. As an average for the past nine years, Dwarf Yellow milo has yielded on the average 29.90 bushels, Spur feterita 29.61 bushels, and Dwarf Blackhul kafir 26.19 bushels to the acre. Kafir is usually harvested with a row binder and the whole crop utilized, so that the difference in grain yield between it and milo and feterita is practically offset by the increased value obtained from the forage.

Later Plantings Grain Sorghums Yield More: In an experiment with grain sorghums bearing on varieties and dates of planting, it has been found that on the average an increased yield is obtained by planting on June 15, rather than on April 15 or May 15. This is especially true of the milos. Varieties of kafir have given better yields when planted at the medium date of May 15, and none of the grain sorghums have responded favorably when planted as early as April 15. The later dates of planting have responded with better yields, due largely to the fact that their fruiting period coincides with a period of more moderate temperatures and a more favorable moisture supply in the latter part of September and October than is the case with the early-planted sorghums, whose fruiting period usually comes during periods of dry weather and high temperature in the late summer. During the past year practically all of the grain sorghums produced higher yields from the June 15 planting than any other date. The fruiting period of the sorghums planted April 15 comes during extremely dry weather, and consequently the yields were reduced to approximately fifty per cent of those produced from the planting a month later.

Breeding Grain Sorghums: Through breeding work with grain sorghums at this Station, several high-yielding strains have been developed and distributed. Blackhul kafir No. 153 is a high-yielding pure line of Standard Blackhul kafir which has been distributed and is widely grown. Texas Blackhul kafir, a high-yielding strain having several characters somewhat intermediate between Dwarf Blackhul and Standard Blackhul, has been developed by this Station. For seven years, Texas Blackhul has averaged 4.4 bushels more grain to the acre than Dwarf kafir, and 3.3 bushels more than Standard kafir. This variety has been given wide distribution and is coming into general use by Texas farmers. Aside from annually distributing large quantities of increase seed of high-yielding pure lines of grain sorghum, the Station is also placing in the hands of careful and reliable farmers small quantities of bagged seed of these improved strains of grain sorghums for increase, thus building up in various communities in the grain-sorghum area pure seed centers where quantities of these superior strains are available. County agents have taken an active part in assisting farmers interested in caring for this seed and in making it available to their neighbors.

Pioneering in Cotton Production: The pioneer work of this Station with cotton in the Plains region has been an important factor in the development of a large cotton area in the northwestern part of the State. Experiments have during the past fifteen years pointed the way toward the best varieties of cotton and the most successful practices in both soil and crop management and practices in the growing of this crop. Bulletin No. 364, "Varieties of Cotton in Northwest Texas," reports results of fifteen years' work with cotton varieties and cotton-growing. During this period, cotton has compared favorable with the sorghums as a drouth-resistant crop adapted to dry-land farming, producing on the average ten pounds of lint to one bushel of grain produced by the best grain sorghums. It has been found that a high pre-season rainfall is, in general, indicative of an average yield of cotton and has almost as effective influence on yield as does seasonal rainfall. When a high pre-season rainfall and a high seasonal rainfall coincide, unusual yields may be expected. While moisture is the limiting factor in cotton production in this area, the crop has the ability to withstand rather severe drouth and still produce profitable yields. Early-maturing varieties have been found to be the most profitable and consistent in production. The medium to early strains of Mebane cotton have been found to give satisfactory yields, possess fair staple of around one inch, and are reasonably storm-resistant. Detailed records on the relation between blooming and opening of different varieties of cotton have shown that those producing the largest number of blooms also give the highest yields, and that as an average for a five-year period the early-maturing varieties have 40 to 60 per cent of their total crop open 140 days after planting, as compared with 20 to 25 per cent for the large-bolled varieties in the same period. Inasmuch as the growing season is ofttimes inadequate, this characteristic of the early-maturing varieties is of importance in en-

abling a variety of cotton to make a consistent and profitable yield. The best varieties of cotton having a staple of 1-1/16 to 1-3/16 inches yielded on the average for eight years 79 per cent as much lint as those having a staple of ⅞ and 1 inch. While the staple length for the different varieties is somewhat reduced in dry years, a comparison of the staple over a period of years shows that it compares favorably in length with the same varieties grown in other parts of the State, and that varieties having a staple of around 1 inch can be grown profitably in this section. Lightning Express, Acala, and Durango are among the best producing varieties of longer staple at this Station. A new variety of cotton named Westex has been developed and distributed from this Station. This variety is very early in maturity and its chief advantage lies in the fact that it has a short growing season and is better adapted to the regions lying north and west of the present line of profitable cotton culture.

Cultural Practices Compared: Experiments in seed-bed preparation and cultural practices with both cotton and the grain sorghums has been under way for the last ten years. It has been found that on the sandy loam type of soil in this area, which is inclined to drift during periods of high winds and where only approximately 15 per cent of the total annual precipitation falls during the winter months, spring preparation of the seed-bed by listing or plowing is as profitable a practice as early preparation. Deep plowing and deep listing to a depth of 7 inches have given higher yields of both cotton and grain sorghum than either shallow listing or shallow plowing. Deep plowing has on the average yielded approximately two bushels more milo to the acre than deep listing, and deep listing has yielded approximately 1½ bushels more than disking. Cotton grown on land prepared by plowing has averaged 211 pounds of lint to the acre as compared with 196 pounds of lint produced on listed land. Late preparation, whether accomplished by listing or plowing, has given higher yields than early preparation. Disking as a means of preparing the seed-bed for cotton has given on the average approximately 50 pounds less lint to the acre than when the soil was prepared by either listing or plowing. Cultural experiments with both cotton and grain sorghums at this Station have shown conclusively that the weed factor is the important element in cultural practices and that when weed growth is completely held in check, either by hoeing or by ordinary methods of cultivation, the important phase of cultivation is accomplished. Plats of both cotton and milo which received a treatment of hoeing for the purpose of keeping down weed growth yielded approximately double the amount of lint and grain that was obtained from plats receiving no treatment and where weeds were allowed to grow, and additional cultural treatment through the use of cultivators equipped with sweeps resulted in an increase of 15 to 20 per cent over the yield obtained when the treatment consisted only of hoeing.

An Experimental Nursery and Plant-introduction Garden is maintained at this Station for the purpose of trying out new trees, shrubs, and ornamentals adapted to the region and for the purpose of stimulating the interest in shade and ornamental plantings in this section. The Chinese elm, a native of China, introduced by the Office of Foreign Seed and Plant Introductions, United States Department of Agriculture, has been given a thorough trial at this Station and has been found to be one of the most promising, hardy, and rapidly-growing shade trees for this section. The Station has made a number of importations of seed from China and has grown and distributed a large number of this valuable tree over the western part of the State. Because of its drouth resistance, rapid growth, and freedom from insects, the Chinese elm is becoming one of the most popular trees for this region. Among the evergreens tried here, it has been found that the Chinese Arborvitae, Red Cedar, Arizona Cypress, and Western Yellow pine are the most hardy and best adapted. The Arizona cypress is a new tree to this region and has proved well adapted and very valuable for ornamental planting. Chinese Arborvitae is a very hardy evergreen that is easily transplanted, drouth-resistant, and well adapted for ornamental and windbreak plantings on the farms of this section.

Substation No. 9, Balmorhea

Substation No. 9 is located four miles east of Balmorhea, on the Pecos Valley & Southern Railroad; latitude 31 degrees north and longitude 103 degrees west; approximately 2500 feet above sea level. The average rainfall over a period of four years was 14.10 inches. The Station property consists of 200 acres with 80 acres under irrigation and the balance in pasture.

This Station is located in the Toyah Valley and at the foot of the Davis Mountains, where irrigation water is available. The work deals primarily with problems confronting the irrigation farmer in the Southwest. The aim of this work is to make farming more profitable under the conditions of soil and climate existing in this region in connection with irrigation practices, by bringing under control, if possible, certain troublesome plant diseases and insect pests and through the introduction of new varieties of horticultural and field crops better adapted to the conditions in this section. The experimental work falls into two general classes: horticulture and agronomy.

At the present time the horticultural work consists largely of the testing out of different kinds and varieties of fruits in an endeavor to determine those best suited to the region and also to find out whether or not it is possible to discover varieties of horticultural crops which are resistant to the cotton root rot disease. This disease is quite prevalent in most of the irrigated valleys in the Southwest and is highly destructive of many horticultural crops. A large number of varieties of fruits, nuts, grapes, berries, and ornamentals are under trial at this point. Definite recommendations regarding the bearing, productiveness,

and adaptability of these fruits cannot be made for some time, since relatively few of those under observation are old enough to produce fruit. Results of observations, however, up to this time indicate that hardy varieties of European grapes, late-blooming varieties of plums and blight-resistant pears will perhaps be the best adapted fruits to the conditions here.

Some Ornamentals Resist Root Rot: The work with ornamentals has indicated that although many species and varieties will withstand the climatic conditions when well supplied with water, only a few of these are immune to attacks of the cotton root rot fungus. Liveoak, pecan, honeysuckle, and the flowering pomegranate appear to be resistant to this disease. The Tamarix and Chinese hackberry also show some resistance but are apparently not immune.

The Agronomic Work consists of the introduction of new or superior crops, determining the value and effectiveness of different fertilizer treatments, and comparative testing of different varieties of farm crops. Results with fertilizers show that very little increase in yield has been secured through the use of fertilizers. Even nitrogenous fertilizers have shown very little effect in stimulating plant growth. This is probably due to the fact that these semi-arid soils are low in organic matter when first put into cultivation and contain considerable plant food but very little humus. Much better yields are obtained after alfalfa has been grown for a few years, and it is possible that phosphatic fertilizers may show greater increases in yields of crops following alfalfa. No beneficial results on crop yields have followed the use of sulphur or potash.

Alfalfa Selection Work: Ten superior strains of alfalfa have been selected for increase and further study, with the view of eliminating all but one or two of these strains, which will be increased and distributed for general planting in this section. These selections are from a lot of forty strains and varieties which have been grown in the alfalfa nursery since 1924. The Hairy Peruvian variety, which is one of the highest-yielding strains, has been found unsuitable for growing in sections where root rot is prevalent, since it does not have the ability to recover from attacks of this disease to the same extent that other varieties have. While higher yields are secured from Hairy Peruvian for the first year or two, the stand is soon reduced by root rot to such an extent that weeds and grass become troublesome.

Acala Cotton Adapted: In the cotton variety tests the Acala variety has proved to be well adapted to irrigated conditions here and is the best variety from the standpoint of yield and quality of staple. Acala cotton is being grown on practically all farms in the Madera Valley at the present time. The grain sorghums have been found to be the most profitable grain crops. Since they are grown in limited acreages, however, considerable damage is usually suffered from birds when the grain

begins to ripen. Corn has not proved to be a profitable crop on this Station because of unfavorable climatic conditions and insect damage.

The work of this Station is being directed toward the establishment of a better balanced system of agriculture, in which cotton and alfalfa are the leading crops, but also through the use of other field and horticultural crops where they may be used to advantage.

Substation No. 10, Feeding and Breeding Station

Substation No. 10 is located one mile northwest of College Station, Brazos County, on the public highway; latitude 30 degrees north and longitude 90 degrees west; 308 feet above sea level. The annual average rainfall over a period of 37 years was 37.93 inches. The lands owned and assigned to the Feeding and Breeding Station comprise 901.8 acres.

The major purpose of this substation is to provide a centralized laboratory near the Main Station and the Agricultural and Mechanical College for studies in feeding, breeding, and management of swine, dairy cattle, and poultry. The work here formerly embraced feeding work with cattle, but owing to existing conditions, this work was transferred where better facilities were available.

The work of this Station is reported upon elsewhere in this report, under the heading of the divisions concerned.

Substation No. 11, Nacogdoches

Substation No. 11 is located two and three-fourths miles north of Nacogdoches, Nacogdoches County, on the Nacogdoches-Timpson highway; latitude 32 degrees north, and longitude 94 degrees west; elevation 292 feet above sea level. The average annual rainfall over a period of 26 years was 50.40 inches. The Station comprises 81.6 acres of land.

The purpose of this Station is to serve the region of Texas composed principally of soils of the Orangeburg series. The red lands of the Orangeburg series are among the earliest settled farm lands in the State. This soil is very productive, but since much of it has been in cultivation for a long time, one of the chief problems is that of systematic and orderly cropping practices to build up and maintain soil fertility. Crop rotation, including legumes and green manure crops to build up soil fertility, the determination of the need of these soils for fertilizers together with the rate and time of application, and the development of horticultural and agronomic crops suited to a diversified agricultural program for this region are outstanding problems with which this Station is primarily concerned.

Soil Fertility Work: Terracing of the land in this section is very important for the conservation of fertility and also the conservation of soil which is otherwise lost through erosion. A program for the maintenance of soil fertility should also include the incorporation of organic matter at every possible opportunity, together with rotation of crops on the land as often as possible and practicable. Fertilizer experiments con-

ducted indicate that increased yields may be obtained through the use of reasonably heavy applications of fertilizers and also indicate that in connection with the use of fertilizers on these soils it is essential that the soil be brought into better physical condition through the plowing under of organic matter and the rotation of crops. In fertilizer experiments with cotton, gains were obtained through the application of potash up to fifty pounds to the acre when muriate of potash was used as the source of potash and applied in combination with 300 pounds of acid phosphate and 150 pounds of nitrate of soda. Yields of cotton over a three-year period have been increased through the use of nitrate of soda and ammonium sulphate as the source of nitrogenous fertilizers. Muriate of potash applied to corn resulted in a slight gain in yield. Commercial fertilizers applied to cowpeas have not shown a consistent gain in yield. Acid phosphate when applied alone seems to show a greater tendency toward a larger gain. Sulphur applied in amounts of 250 and 500 pounds to the acre produced a slight gain in the yield of cowpeas, but this gain was not sufficient to pay for the sulphur used. A variety of different crops have been grown and tested under the conditions found at this Station with a view of establishing the best crops and crop strains, thus making available to the farmer those crops which can best be used to advantage in connection with a system of building up and maintaining soil fertility.

The Macspan Peanut: A selection from the Little Spanish variety has made a more vigorous growth and produced a greater uniformity of yield in nuts. This selection is being increased at this and other Stations and distributed to growers in the more important peanut-growing areas of the State.

Highest Yielding Corn and Peas: The results of corn variety and date of planting test over a period of nine years show that Hastings Prolific, Brazos White, Surcropper, and Chisholm are the highest-yielding varieties, and the more profitable yields are derived from early planting. Whippoorwill, New Era, Clay, and Unknown cowpeas are the best varieties for this section when used for hay or for plowing under for soil improvement.

Cotton Variety Tests: Eleven varieties of cotton were planted this year in the variety test, Bennett's Lone Star was the high producer of lint, with 217 pounds to the acre. Acala and Belton yielded 211 pounds each of lint, and were the second high yielders in the test. For the six-year period, 1922 to 1927, Acala is the high yielder with an average yield of 161.1 pounds of lint to the acre, Lightning Express is second with 157.2 pounds, and Truitt is the third high yielder with 152.3 pounds of lint cotton to the acre.

Substation No. 12, Chillicothe

Substation No. 12 is located four and one-half miles south and one mile west of Chillicothe, Hardeman County; longitude 99 degrees west,

and latitude 34 degrees north; elevation 1406 feet above sea level. The annual rainfall over a period of 22 years was 25.87 inches. The Station comprises an area of 100 acres of land and serves a region in the northern part of the Redbeds area, in which the Vernon and Kirkland series are the principal soils.

This Station was established as a cooperative forage-crop testing station, operated jointly by the Office of Forage Crop Investigations, United States Department of Agriculture, and the Texas Agricultural Experiment Station. The work with forage-crop testing at this Station has been productive of a number of important crops which since their introduction have assumed an important place in the agriculture of this region, and while the introduction and testing work has been going on for a number of years, it is being continued vigorously by assembling and testing out forage crops from every part of the world in order to determine their value under the conditions found in the Southern Great Plains area, including the western part of Texas.

Chiltex and Premo Find Favor: In recent years the experimental work of this Station has been extended so as to include cotton, sorghums, small grain, legumes, and other field crops important to the region. The work with forage and grain sorghums includes the testing of varieties, introduction, breeding, and cultural methods. Two new varieties of grain sorghum distributed from this Station in recent years and known as Chiltex and Premo have found favor among farmers and an additional distribution of 15,000 pounds of seed of these two varieties was made the past year. Sorghum work through hybridization in an endeavor to find high-yielding selections from recombinations is an important phase of the work at this Station. During the past year over 300 head rows of unclassified sorgos collected throughout the Southern States and the sorghum region of the Southwest were grown for the purpose of identification and classification.

A Sorghum Disease Appears: An apparently new disease of sorghum which has confined its attack largely to milo has appeared in this region and is receiving attention at this Station in cooperation with the United States Department of Agriculture. This disease markedly affects the development of the milo plant, resulting in almost a complete loss on small, confined areas in the field where it appears. A more complete determination of the cause of this disease involves the isolation of the organism and the determination of the probable part that the chinch bug plays in disseminating the disease.

Results of Experiments with Cotton at this station are reported in Bulletin No. 366, "Varieties of Cotton in the Red Prairies of Northwest Texas," which has been published during the year. The varieties producing the highest yield are early, have a relatively high lint percentage and produce lint of one inch or under in length. A detailed and intensive study of the characteristics of different varieties of cotton is

being made in an effort to obtain knowledge as to the structural differences, such as the formation of the fruiting and vegetative branches, and other differences which may be characteristic of the various commercial varieties of cotton used in this region. As the result of cotton-breeding work, a number of promising strains have been isolated from a type of Mebane cotton. The best one of these selections is now being increased with a view of distributing seed to farmers of this region the coming year.

Work with Small Grains indicates the superiority of an early strain of spring oats of the Fulghum type, and red winter wheat of the Kanred variety for this station. Experiments on the time and method of preparation of the seed-bed for wheat during the past nine years show a much greater difference in yield due to time of preparation than there is due to the method of preparation. Plowing appears to be the best method of preparation and the land should be prepared early in July.

Legumes and Grasses: Austrian Winter Field Peas are a promising crop for growing on sandy soils that have a tendency to blow. For the best growth of this crop, however, the necessary early spring moisture is sometimes lacking. Sweet clover has been found to be a fairly satisfactory legume for this section, the best stands being secured by winter planting during December, January, or February. A number of perennial grasses, including *Cynodon barberi,* Giant Bermuda; Angleton Grass; *Paspalum buckleyanum,* and *Paspalum sp.,* give indications from the trials to date of having a value for the conditions found in this region.

Fertilizer for Cotton: Cotton is the principal crop in this section, and there is demand for information as to the value and desirability of using commercial fertilizers in connection with cotton production here. A fertilizer experiment with cotton involving fifteen combinations or formulas has been under trial for the past three years and the results during this period indicate that little or no increase in yield of cotton can be expected to follow the application of fertilizers to this crop. While eventually commercial fertilizers may be necessary in this region, it seems that the limiting factor at the present time on the type of soil occupied by this station is soil moisture rather than soil fertility.

Substation No. 14, Sonora

Substation No. 14 is located 26 miles southeast of Sonora, on the Sonora-Rock Springs road; latitude 30 degrees north, and longitude 100 degrees west; elevation, approximately 2400 feet above sea level. The annual average rainfall over a period of nine years is 24.20 inches. The Station lands consist of 3452 acres, serving the region known as the Edwards Plateau and comprising an area where the Angora goat and sheep industries are important and highly centralized.

The purpose of the station is to study systematically the agricultural

problems of the region, collect exact and comparative data, and analyze these with the view of establishing basic facts and principles which can be depended upon in the successful operation and development of the agriculture of the section. Some of the more important lines of work carried at this station are as follows:

Adaptation of Breeds of Sheep: The Corriedale sheep is being compared with the Rambouillet for use under conditions here in a project in cooperation with the Bureau of Animal Industry, United States Department of Agriculture. The Corriedale originated in New Zealand and is of comparatively recent origin and is a result of fixing the type between the long- and fine-wool foundation and is therefore a medium-wool breed of splendid mutton conformation and good shearing qualities. The data thus far indicate that this breed is not so well adapted to Southwest Texas range conditions as is the Rambouillet breed.

Breeding Investigations: Studies are being made at Substation No. 14 of the type and inheritance of characters in Rambouillet sheep, Angora goats, and Hereford-Brahma cattle crosses. These results are fully reported elsewhere in this bulletin under the Division of Range Animal Husbandry.

Flock and Herd Management Studies: Records are being made of several phases of livestock management, including the percentage of lamb, kid, and calf crop, death losses, shearing and marketing methods, and other phases which have to do with the problems involved in ranching.

Stomach Worms and Other Internal Parasites: A study of the most effective means of combating stomach worms in sheep and Angora goats has indicated thus far that copper sulphate (bluestone) treatment has proved the most satisfactory treatment for range flocks for stomach-worm eradication. The life history of this parasite has been fairly well worked out under other conditions; its behavior under range conditions in this section is now being studied. This knowledge may contribute to more effective management and treatment with reference to range flocks.

External Parasites Affecting Sheep and Goats: Studies of the screw-worm fly, the wool-maggot fly, and the several different kinds of goat lice, and a study of the life history of the scab mite under conditions in this section are all being carried cooperatively with the Bureau of Entomology, United States Department of Agriculture, through the assignment of an entomologist to work in connection with this station. Fly-trapping has proved to be very effective and much information has been secured as to the most effective types of fly traps, the most effective bait, and the proper management of traps. Fly repellants and worm killers are also being studied as to their effectiveness. An extensive series of treatments are being carried with reference to their efficiency as goat-lice killers. Life-history studies of goat lice are also being made

in this cooperative project with encouraging prospects for the development of proper systems of dipping for the complete eradication of lice. A sheep-scab-mite study begun in 1924 is developing some new facts in relation to the longevity of the scab mite and to its communication from one animal to another. Considerable work has been done in the effectiveness of different dips in the eradication of scab. This work will be reported on fully at an early date when it is hoped that conclusive results will be available.

Swellhead of Sheep and Goats is one of the important diseases being studied. Progress in this work has been slow during the past two or three years, but recent work has developed some important leads which may result in determining the cause of this trouble and a means of control. Studies of this character of trouble of unknown cause are difficult studies and require considerable time and careful work. The most recent developments tend to indicate that this trouble may be due to an organism, but this phase of the work has not progressed sufficiently to justify a positive statement that it is due to an organism and not to some other cause.

Soremouth is a condition affecting either mature sheep or lambs, but the chief losses incurred are losses in development of lambs affected. Recent developments have suggested that there might be some relation between soremouth and swellhead. In the meantime, the most effective curative agencies are being sought, but the control or elimination of this trouble seems to lie in the determination of its cause and the full understanding of the conditions under which the trouble develops.

Range Vegetation Studies: Studies are being made as to the character and economic importance of the native vegetation of the Edwards Plateau region for grazing purposes. The gradual changes in the vegetation of the area are of importance and affect the value of the region for grazing purposes. The evidence thus far indicates that there is a gradual increasing of woody plants at the expense of the grassy cover. Such changes would naturally increase the amount of browsing and decrease the amount of grazing. These studies are being made by a system of recording vegetation maps for certain areas on the Station from year to year with the view of obtaining accurate information as to the competition of species of plants for occupancy of the range.

Activities of Livestock: Studies of the activities of livestock under range conditions have been under way now for three years. The results of this work have been published in Bulletin No. 367, "Activities of Livestock on the Range," and show the tendency of different animals to utilize the different species of vegetation on the range, the time occupied in feeding, resting, watering, traveling, and other activities of range livestock under range conditions.

Carrying Capacity Studies: The purpose of this study is to determine the carrying capacity of the Experiment Station ranch stocked with

cattle, sheep, and goats. The results to date referred to under the Division of Farm and Ranch Economics indicate that the carrying capacity of the range on the Experiment Station ranch is perhaps somewhat greater than that being utilized at the present time. The data are complete for four years and it is hoped that the complete analysis of these four years' data will show results sufficiently conclusive for a publication indicating the correct carrying capacity for the Edwards Plateau range.

Substation No. 15, Weslaco

Substation No. 15 is centrally located in the Lower Rio Grande Valley. The station lies adjacent to Llano Grande Switch in Hidalgo County, bordering the concrete highway traversing the Valley and about midway between Weslaco and Mercedes. The farm comprises 100 acres of land, composed of Victoria Fine Sandy Loam and irrigated by water pumped from the Rio Grande by a privately owned irrigation company. The land is utilized at present as follows: fifty-five acres in experiments; 17 acres in field crops; 24 acres in roads, canals, and waste land; and three acres in farmstead.

The work of this station may be divided into the following groups: citrus fruits, vegetables, insect pest control, plant introduction, field-crop experiments, and Texas root rot disease research with fruit and vegetable crops. The Lower Rio Grande Valley Station was established primarily for the investigation of problems relating to the commercial production of citrus fruits and vegetables, plant introductions, and work with field crops. There is a wide variety of problems here and the experiments have in view the finding of the best combinations of crops for use in this section.

At the time of the establishment of this station it had a ten-acre orchard of Marsh seedless grapefruit consisting of about 1,000 trees. This ten-acre grapefruit grove, three acres of mixed varieties of citrus fruit, and four acres of mixed varieties of deciduous fruit trees comprise the present plantings. These are being used in orchard-management studies, pest-control work, and studies of the Texas root rot disease. The aged grapefruit orchard is devoted to soil-management investigations and pest-control work. The soil-management studies are divided into fertilizer tests, cover-crop experiments, and cultural-methods tests. The fertilizer work with the aged grapefruit trees has not shown conclusive results up to the present time, as the results are difficult to interpret because of the great amount of differences in the yielding habits of different trees. Water requirements and wind protection have been found to be more important factors in the production of grapefruit than soil fertility up to the present time. As the orchard trees grow older, soil fertility will probably become more important than it appears to be now. Cover-crop areas receiving fifty per cent more irrigation water than clean-cultivated plats produced more and larger fruit. Results obtained the past two years point to the fact that the proper use of irri-

gation water is one of the most important problems of the citrus grower and is essential to satisfactory production.

The Citrus Orchard: Both commercial and rare varieties of citrus fruits are included in plant introduction work in the young citrus orchard, with a view of determining their adaptibility as fruiting plants or for rootstocks. Most of these trees are less than three years old and have not fruited to date. The Meyer or dwarf Chinese lemon, Clementine orange, and the Eustis limequat appear to be more cold-resistant than the commercial varieties of these fruits. The Calamondis seems promising as a rootstock upon which to work limes, limequats, mandarin oranges, and Meyer lemons, since these fruits do not seem to thrive on the most commonly used sour-orange stock. The Rusk Citrange and Meyer lemon also offer possibilities as rootstock, but their resistance to root rot has yet to be established. The fact that these stocks may be vegetatively propagated is a point in their favor.

Citrus Pests: The California Red Scale is the most serious insect pest attacking citrus trees in the Valley. Experiments looking toward the control of this pest during the past two seasons have shown that some of the oil sprays have a very harmful effect on the trees. Spraying thoroughly with some approved oil spray during the months of May and July may be expected to give commercial control of this pest. What the final cumulative effect of these materials will be is yet to be determined. Other methods of combating citrus insect pests are being studied, and fumigation with calcium cyanide dust has given excellent kills when properly used.

Orchard Varieties: A number of both rare and commonly known varieties of peaches, plums, apricots, pears, persimmons, figs, grapes, and pecans have been planted. These trees are all less than three years old and definite data on their fruiting habits have not been obtained. The Texas root rot disease has practically killed out the plantings of figs, grapes, and olives that were made in the spring of 1925. The Mustang grape (*Vitis candicans*) and some of the Munson hybrids of Mustang origin appear to be hardy and resistant to this disease. *Rupestris* St. George hybrid stocks which are commonly used in some sections of California seem to be quite susceptible to root rot. Olives, figs, pomegranates, roses, *Euonymus, Ligustrums,* Arizona cypress, and Chinese elm appear susceptible to this disease. *Rosa odorata* offers promise of being a more satisfactory stock for roses in this section than the commonly used stocks.

Experiments with Vegetable Crops during the past year consisted of a study of the principal strains and varieties of commercially important vegetable crops and cultural methods with some of the more important vegetables. New York, or Wonderful lettuce, was the most desirable variety this season. Endive was grown for comparison with lettuce and as a salad crop it seems to be fully the equal of good lettuce from

the standpoint of yield and appears to be more resistant to adverse weather conditions. Marked difference was noted in the uniformity of different strains of the same variety of cabbage. Several of the Copenhagen Market strains were markedly different in uniformity and type, time of maturity, tendency to split, and in head formation. Similar variations were noted, but to a much less degree, in the Glory of Enkhuizen variety. Copenhagen Market is a very excellent early cabbage for this section, but the Glory of Enkhuizen is probably the best main crop cabbage for the valley farmers to grow. Early Snowball cauliflower was the most satisfactory variety this year, but unfavorable weather interfered with the maturity of this crop, as it has done in the two previous seasons. The climatic conditions here seem to make the growing of cauliflower an uncertain enterprise. The Chantenay carrot again outyielded all other varieties. While the Hutchison strain of Danvers compared favorably with the best strains of Chantenay, it was lighter in color and more tapering than the latter. Lack of stand through unfavorable weather conditions and thin seeding to avoid thinning was an important factor in affecting the yield of carrots in many sections of the Valley this season. Certain strains of Crosby's Egyptian beets were much more uniform than many of the commercial strains offered for sale in the Valley. Detroit Dark Red is more uniform than Crosby's Egyptian, but is smaller, later in maturing, and gives a lower yield. Certain strains of Cooper's Special tomatoes produced the best yields. The self-topping habit of this variety probably accounts for its more favorable showing during the unfavorable season of 1927.

Treatment for Powdery Mildew Not Effective: The time of applying sulphur dust and Bordeaux spray to cantaloupes for the control of powdery and downy mildew does not seem to materially increase or decrease the injurious effects of these materials to cucurbit foliage. Untreated vines set a heavier crop of melons and matured their crop fully two weeks ahead of treated vines. Bordeaux produced a chlorotic condition of cantaloupe leaves, while sulphur actually killed the foliage except on the growing tips.

Commercial Fertilizer of an 8-4-4 formula failed to materially increase yields of tomatoes or cantaloupes and apparently did not materially reduce the percentage of "puffy" tomatoes.

Onion Thrips appearing early in the season were the limiting factor in onion production. Several insecticide materials gave excellent kills, but reinfestation appeared quickly. Emergence of the soil stages of thrips reached a peak of 150 a day from each square foot of soil. Further studies in the control of these soil stages of thrips constituted an important line of investigation which should be undertaken here.

In Seed Treatments for the Control of Potato Scab it was found that organic mercury compounds stimulated growth and were fairly effective in controlling scab. Formaldehyde treatments reduced the stand by

killing the weak seed pieces. Dry sulphur applied in liberal quantities to cut seed pieces previously dipped in starch solution gave more satisfactory scab control than any other treatment used. Potato plats that were subirrigated by seepage water from laterals produced much larger yields than the plats receiving the regular cultural treatment and irrigation.

Parsley was found to be well adapted to valley conditions. Excellent crops of all three types were grown, but methods of seeding that will insure a uniform stand need to be developed through further study.

Corn Experiments: Tuxpan corn produced the highest yield this season. Brazos White, because of its large size and earliness, offers promise as a variety for early roasting-ear production. Rather thick seeding, cutworm control, and close attention to irrigation were found to be very important factors in the growing of corn. Rather thick spacing gave the highest yields with most varieties.

Cotton Varieties: Delfos No. 6102, Acala, and strains 4, 6 and 8 of D. P. L. cotton ranked the highest in yield. The securing of uniform stands is one of the principal problems in cotton-growing under irrigation. The seed of certain strains seem to be much less viable than that of other strains, and this seems to be more especially true of the rank-growing varieties. Further studies on the spacing of cotton indicate that thicker spacing than nine inches between plants yields better returns than where the wider space is allowed between plants in the row.

Plant Introductions: Mung beans and Laredo soy beans compared favorable with cowpeas in forage production, but appeared more susceptible to the cotton root rot disease. Para grass and Angleton grass were introduced on the station this year, both of which have made a very excellent growth and are of considerable promise as pasture grasses for this section. A runner growth of twenty feet was made by the Para grass in six months' time. A number of plant introductions have been collected and are being grown on this station at the present time. The Meyer lemon and Clementine orange are the most important additions to the collection of citrus varieties. *Bauhinia tomentosa,* a handsome leguminous shrub from Java, which produces an abundance of showy flowers, made excellent growth this season.

The Possibility of Successful Commercial Date Growing in South Texas is an important new phase of the work of this station taken up during the present year. Through the splendid cooperation of Dr. W. T. Swingle, United States Department of Agriculture, thirty offshoots of commercial dates, including the varieties which offer promise under the conditions in South Texas, have been obtained from the Indio Date Gardens, Indio, California, and transplanted on this station. These offshoots were cooked so as to prevent the possibility of transmission of insects and diseases of the date, and from results obtained in rooting

these cooked offshoots it seems that it is practicable to import them for the establishment of experimental date plantings in this region to the extent that the supply will permit and that may be desirable for a thorough investigation of the date-growing possibilities.

Substation No. 16, Iowa Park

Substation No. 16 is located two and one-half miles southwest of Iowa Park, Wichita County, on the Fort Worth & Denver City Railway; latitude 33 degrees and 55 minutes north, and longitude 98 degrees and 39 minutes west; elevation 974 feet above sea level. The average annual rainfall for the past four years has been 26.38 inches. The station comprises 161.79 acres of land, of which 100 acres are under cultivation. The soils are chiefly of the Yahola and Miller series, which are typical alluvial soils found along the many Texas streams.

This substation was established late in 1924 and the first two years were devoted largely to general farming and development work in preparation for experimental work to follow later. A number of buildings and other structures have been placed on the grounds, and equipment added until at the present time most of the facilities necessary to carry on research work have been provided. During the year a new office and laboratory building, barn, machine shed, and residence have been completed, so that the station is fairly well equipped to begin more intensive work along experimental lines.

Practically all of the lands of this station are subject to irrigation, and the tilled area is now being served by irrigation water. The chief purpose of the station is to serve under conditions found in the irrigated area comprising the new Wichita Irrigation Project, and results obtained here should likewise be of value in the development of other similar projects in West Texas where similar soils and conditions exist.

Among the objectives of this station is the accumulation of information which will aid in the development of agriculture in this valley along profitable lines. The preliminary experiments will be confined chiefly to those which will fit into a profitable farm cropping program. Research work the past season was confined to field crops, orchard and garden, and to some of the problems closely allied to horticultural and field crops.

Cotton Varieties: Twenty-two varieties and strains of cotton were placed in varietal tests on the Yahola soils in 1926. The average yields showed Half and Half and a new variety from a cross between Durango and Half and Half to be on an equality in yield, each producing 1239 pounds of seed cotton to the acre. D. P. L. No. 8 made 1144 pounds of seed cotton to the acre, while Delfos was fourth in yield with 1041 pounds of seed cotton to the acre. Several unfavorable conditions tended to reduce cotton yields this season.

Feed and Forage Crops: The grain sorghums are the most dependable grain crops for this region. Chiltex, a new hybrid grain sorghum,

yielded 35 bushels of threshed grain to the acre in comparison with a yield of 28 bushels produced by Standard Blackhul kafir. Kafir exhibited greater resistance to chinchbug damage than did other grain sorghums. Six varieties of corn were grown this year, all producing low yields, on account of a period of hot winds. Among seven varieties of cowpeas grown, Groit and Brabham produced the most satisfactory forage yields, while Chinese Red produced the largest yield of seed. Field areas of Common, Grimm, Turkestan, and Hairy Peruvian alfalfa were destroyed by the cotton root rot disease before complete records on their relative merits were obtained, and these fields were placed in other crops during the year. Hairy Peruvian alfalfa survived the longest and produced a fair crop during part of the third summer. This variety, contrary to general belief, proved to be winter-hardy during the past two years. Turkestan was found to be the least desirable variety of alfalfa for this section. A field area of biennial white sweet clover sown last year made a luxuriant growth this spring and attained a height of four to five feet. No difference was noted in the stand between that part of the area which was planted with oats as a nurse crop and the part planted without a nurse crop. More difficulty, however, was encountered with the sunflowers and other weeds where the sweet clover was seeded without a nurse crop. Guar, velvet beans, mung beans, and other legumes were grown to determine their adaptability and resistance to the cotton root rot disease. Guar made a fair growth and showed 99 per cent resistance to root rot. The mung bean fruited heavily and was fairly susceptible to root rot, but seemed to be worthy of further trial. Velvet beans were very susceptible to the cotton root rot disease.

Kanota Oats have proved winter-hardy during the past two winters and this year yielded 31 bushels to the acre in comparison with 23 bushels produced by the Red Rust-proof variety. Wisconsin Winter barley yielded 13.8 bushels and Manchurian barley yielded 9.2 bushels, while rye produced 8.3 bushels to the acre.

Sugar Beet Experiments: An experiment designed to test out the adaptability of sugar beets for growing under irrigation in the Wichita Valley and determination of their sugar content was begun this year. Seed imported from Poland yielded at the rate of 10.08 tons, Vilmorin's Improved 6.74, Klein Wanzleben 6.28 tons, and Lane's Improved 5.45 tons of beets to the acre. The Polish beets tested 15.88 per cent sugar and 72.55 per cent purity. Vilmorin's Improved ranked the lowest in sugar content, averaging 13.9 per cent sugar and 67.47 per cent purity.

Orchard Tests: A young orchard, including approximately 500 fruit trees, representing all of the varieties common to this latitude, was planted last year. Peaches have made satisfactory growth and apples generally conceded to be not well adapted to this region have made good growth, but some of the trees have died from root rot. Cherries have made poor growth. Grapes have shown considerable susceptibility to

the cotton root rot disease, but the Spanish Mission and Muscat of Alexander indicate that they are adapted to the soil and climatic conditions of the region.

Cantaloupes grown under irrigation produced melons of excellent quality and good yields, and indications are that this crop may be grown on a large scale for carload shipments to eastern consuming centers. Rocky-ford cantaloupes produced 127 crates to the acre, while Hearts of Gold produced 87 crates. Burrell's Gem yielded 118 crates, and while it is a melon of good quality, splits frequently occurred while ripening in the field. Cannonball produced 190 12-melon crates; however, the quality is inferior and demand would probably be limited to local markets.

Peas and Beans: Early Alaska peas gave satisfactory yields and were earlier than Thomas Laxton peas. String beans promise to be a successful vegetable here except in mid-summer. Burpee's Stringless Green Pod produced more satisfactory yields than either the Red Valentine or the Kentucky Wonder. Spinach was successfully grown during the winter and early spring, yielding 3840 pounds or 192 baskets, and found a good demand on the local market.

Cotton Root Rot Studies: An important phase of the work of this station is concerned with research in connection with the cotton root rot disease, emphasizing particularly studies of this disease as it attacks alfalfa, cotton, fruit trees, and ornamentals, looking toward a practical means of control. The research work on this disease falls under various lines of inquiry, which may be stated as follows: to determine the effect of organic matter and commercial fertilizers on the susceptibility of cotton to the root rot organism on Miller Clay Loam and Yahola Fine Sandy Loam; to determine the effect of different spacings of cotton upon the development of the root system and to study the relation of root development to the spread of the disease; to determine the effect of the previous crop upon the development of the cotton root rot disease in cotton the following year; to study the effect of flooding for 5, 10, 15, or 20 days on the control of the root rot organism, and to study the morphology and physiology of the organism itself. Alfalfa, which is not grown extensively in the Valley at the present time, is a crop admirably adapted to intensive farming and irrigation practices and would undoubtedly find a profitable place in the farming system of the region. Rather severe losses in the past have been suffered through attacks on the alfalfa crop by the cotton root rot disease organism. For this reason special emphasis is being laid on a study of this disease in relation to alfalfa and other legumes, with a view of overcoming this handicap through the introduction or development of resistant strains or varieties, or through irrigation practices or soil and crop management, so as to reduce the losses to a minimum.

Studies of New Possibilities: In order to develop the possibilities of additional agricultural enterprises in the region, a project was begun

during the present year in cooperation with the Tobacco By-products Corporation of America in order to determine whether or not tobacco of high nicotine content, together with high yield, can be profitably produced under the irrigation conditions in this area. There has also been considerable interest on the part of a number of citizens of this area in testing out the feasibility of growing rice on the irrigation project and experiments including the testing out of three different varieties of rice, to which water is being supplied from a storage reservoir on the station, have been started. Cotton is, and will doubtless continue to be, one of the major crops grown under irrigation here. A new project begun during the year is a study of the effect of various fertilizers and different combinations of fertilizers upon the length, strength, and spinning qualities of cotton lint. The conditions here are favorable for growing cotton of a high-quality staple and the conditions and treatment under which this quality and uniformity can best be produced and maintained will be productive of helpful information toward maintaining quality production.

COOPERATION

In accordance with the long-established policy of the Texas Station to cooperate whenever cooperation may be mutually desirable, formal agreements providing for cooperative research have been entered into or continued during the year as follows:

1. Office of Forage Crops, Bureau of Plant Industry, United States Department of Agriculture, in the operation of Substation No. 12, Chillicothe, Texas, and in general forage crops throughout the State.
2. Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, for the introduction, propagation, and distribution of newly introduced plants which give promise of becoming valuable in Texas.
3. Office of Cotton and Truck-Diseases and Sugar-Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture, for an annual plant disease survey in Texas and for a general study of plant diseases.
4. Bureau of Chemistry and Soils, United States Department of Agriculture, for the conduct of soil-survey work in Texas.
5. Bureau of Entomology, United States Department of Agriculture, for cooperative investigations of insects and parasites affecting livestock.
6. Bureau of Animal Industry, United States Department of Agriculture, for investigations as to the adaptability of Corriedale sheep to Texas conditions, the study of soft-pork problems, and cattle feeding and killing qualities.
7. Bureau of Animal Industry, United States Department of Agriculture, for studies in wool and other animal fibers.
8. Bureau of Agricultural Economics, United States Department of Agriculture, for studies of the following subjects:
   - Farmers' and ranchmen's business organizations and studies of local cotton marketing.
   - Economy of production of picked, snapped, and sledded cotton, and cooperative spinning tests of these cottons.
   - Grade and staple estimates and primary-market price studies.
   - An economic study of the agriculture of the Elephant Butte irrigation project.

9. Bureau of Public Roads, United States Department of Agriculture, for investigations as to the use of water in the growing of rice under the Neches Canal System, the amounts supplied by pumping and rainfall, and the amounts lost by evaporation, drainage, and unavoidable waste.
10. Bureaus of Agricultural Economics and Public Roads, United States Department of Agriculture, for investigations relating to large scale cotton production in Texas.
11. Bureaus of Public Roads and Plant Industry, United States Department of Agriculture, for studies of the small combine harvesting of grain crops.
12. Bureau of Public Roads, United States Department of Agriculture, for studies of the factors which govern the use and adaptability of cotton harvesting machinery.
13. Bureau of Biological Survey, and the Director of Extension Service of the United States Department of Agriculture, for rodent control work in Texas.
14. Freeport Sulphur Company, in furnishing funds and materials for the study of sulphur as a fertilizer, as an insecticide, and as a fungicide.
15. The Barrett Company of Texas, for cooperation in fertilizer work with rice by furnishing fertilizer materials.
16. Chilean Nitrate of Soda Educational Bureau, for the study of the application of nitrate of soda to soils.
17. School of Agriculture, Agricultural and Mechanical College of Texas, wherein Station men may give lectures to students and teachers may do cooperative investigation work for the Station.
18. School of Veterinary Medicine, Agricultural and Mechanical College of Texas, whereby the Dean of the School of Veterinary Medicine acts as Chief of the Division of Veterinary Science for the Station.
19. School of Engineering, Agricultural and Mechanical College of Texas, wherein certain professors may cooperate with the Station workers in agricultural studies involving engineering problems, and more particularly in the study of "The Relation of Electricity to Agriculture."
20. Extension Service, Agricultural and Mechanical College of Texas, wherein Extension Service workers from time to time suggest the more important problems confronting Texas farmers and stockmen and certain Extension specialists cooperate with the Station in making certain investigations mutually agreed upon.
21. Denton County Pure Seed Association, for the increase and distribution of outstanding strains of small grains, particularly Denton wheat and Nortex oats.
22. Texas State Livestock Sanitary Commission, in studies of the sheep scab mite and the Ranch Experiment Station.
23. Western Weighing and Inspection Bureau of Dallas, wherein the railroads of the State and Southwest furnish a fund for the conduct of research and investigations of the various transit and storage diseases affecting fruits, vegetables, and other field crops.
24. The Texas Cotton Seed Crushers Association, in furnishing cotton seed feeds in connection with utilization studies with cottonseed products, and in furnishing funds for the conduct of studies of the feeding of cottonseed products.
25. The King Ranch, in cattle feeding studies, in which the King ranch, Kingsville, Texas, has furnished cattle, feeds, and labor used in feeding-work studies by this Station and the Bureau of Animal Industry.

FINANCIAL STATEMENT

Texas Agricultural Experiment Station

COLLEGE STATION, TEXAS, October 7, 1927.

Acting Director A. B. Conner, Texas Agricultural Experiment Station System.

DEAR SIR: I do hereby certify that to the best of my knowledge and belief the following report upon the receipts and disbursements of the several funds devoted to the development, maintenance and support of the Texas Agricultural Experiment Station System correctly reflects the official accounts for the fiscal year ending August 31, 1927.

(Signed) M. P. HOLLEMAN, JR.,
Chief Clerk (Bonded).

Subscribed and sworn to before me, J. K. Francklow, Notary Public in and for Brazos County, Texas, on the 7th day of October, A. D. 1927.

(Signed) J. K. FRANCKLOW,
Notary Public in and for Brazos County, Texas.

(SEAL)

FUNDS AVAILABLE

	Amount
Total	$ 636,220.24
HATCH FUND, from United States Treasurer for the year ending June 30, 1927	$ 15,000.00
ADAMS FUND, from United States Treasurer for the year ending June 30, 1927	15,000.00
PURNELL FUND, from United States Treasurer for the year ending June 30, 1927	30,000.00
MAIN STATION, from State Treasurer for the year ending August 31, 1927	191,956.76
MAIN STATION, from State Treasurer (unexpended balance from the year ending August 31, 1926)	12,011.73
SUBSTATIONS, from State Treasurer for the year ending August 31, 1927	113,870.00
SUBSTATIONS, from State Treasurer (unexpended balance from the year ending August 31, 1926)	3,389.91
MAIN STATION TREASURY, from sale of products for the year ending August 31, 1927, including balance brought forward	40,110.90
SUBSTATION TREASURY, from sale of products for the year ending August 31, 1927, including balance brought forward	96,727.11
FEED CONTROL SERVICE, from sale of tags for year ending August 31, 1927	118,153.83

CLASSIFICATION OF EXPENDITURES

	Amount
Total	$ 636,220.24
Salaries	$ 220,744.74
Labor and wages	78,357.13
Stationery and office supplies	4,286.82
Scientific supplies (consumable)	6,448.28
Feeding stuffs	18,092.10
Sundry supplies	25,544.55
Fertilizers	794.25
Communication service	3,379.57
Travel expenses	33,749.90
Transportation of things	5,182.58
Publications	14,183.56
Heat, light, water and power	8,423.47
Furniture and fixtures (office equipment)	5,578.18
Library	1,100.32
Scientific equipment	9,293.17
Live stock	6,196.71
Tools, machinery and appliances	15,560.45
Buildings and land	34,437.38
Chemical analyses and tag refunds	13,172.19
Contingent	5,686.30
Transfers	3,192.54
Feed Control surplus remitted to Treasurer of College	56,709.29
Reverted to State Treasury (1925-26 unexpended balance)	2,601.96
Unexpended balance (as of August 31, 1927)	63,504.80

ANALYSIS OF UNEXPENDED BALANCE AS OF AUGUST 31, 1927

	Amount
Total	$ 63,504.80
Main Station Appropriation	$ 19,120.85
Substation Appropriation	8,074.38
Main Station Sales Fund	13,365.11
Substation Sales Fund	22,944.46

FEDERAL FUNDS

Total	$ 60,000.00

HATCH FUND

Items	Debit	Credit
Total	$ 15,000.00	$ 15,000.00
Received from Treasurer of the United States	$ 15,000.00	
Salaries		$ 12,584.96
Labor and wages		1,000.00
Stationery and office supplies		185.70
Sundry supplies		165.20
Communication service		74.33
Scientific equipment		45.00
Live stock		794.81
Buildings and lands		150.00

ADAMS FUND

Items	Debit	Credit
Total	$ 15,000.00	$ 15,000.00
Received from Treasurer of the United States	$ 15,000.00	
Salaries		$ 13,125.00
Labor and wages		897.67
Scientific supplies (consumable)		545.31
Feeding stuffs		138.56
Sundry supplies		58.55
Communication service		.03
Transportation of things		44.94
Heat, light, water and power		38.34
Scientific equipment		85.50
Live stock		50.00
Contingent		16.10

PURNELL FUND

Items	Debit	Credit
Total	$ 30,000.00	$ 30,000.00
Received from Treasurer of the United States	$ 30,000.00	
Salaries		$ 13,685.00
Labor and wages		5,335.18
Stationery and office supplies		596.25
Scientific supplies (consumable)		828.04
Feeding stuffs		350.34
Sundry supplies		232.76
Communication service		72.37
Travel expenses		1,069.01
Transportation of things		188.80
Publications		4.50
Furniture and fixtures (office equipment)		1,929.35
Library		45.40
Scientific equipment		2,567.00
Live stock		87.50
Tools, machinery and appliances		78.64
Buildings and lands		2,929.86

STATE APPROPRIATIONS

MAIN STATION

Division	Debit	Credit
Total	$ 191,956.76	$ 191,956.76
Received from the State Treasurer	$ 191,956.76	
Salaries		$ 51,560.78
Administrative		8,719.63
Cotton Insect Investigations		12,186.13
Cotton Root Rot Investigations		25,621.49
Veterinary Science		5,340.18
Horticulture		4,080.87
Range Animal Husbandry		6,196.46
Entomology		3,976.81
Foul Brood		8,792.97
Agronomy		3,901.61
Plant Pathology and Physiology		2,937.93
Soil Survey		9,000.00
Farm and Ranch Economics		6,578.31
Botany		236.71
Publications		7,306.79
State Apicultural Research Laboratory		8,465.06
Main Station Farm		6,530.57
Reserve		1,403.61
Balance unexpended (vouchers pending)		19,120.85

MAIN STATION

Division	Debit	Credit
Total	$ 12,011.73	$ 12,011.73
Received from the State Treasurer (unexpended balance from 1925-26 appropriation)	$ 12,011.73	
Salaries		.....
Administrative		$ 1,228.30
Veterinary Science		145.90
Horticulture		403.92
Range Animal Husbandry		179.31
Entomology		323.45
Foul Brood		198.22
Agronomy		444.80
Plant Pathology and Physiology		37.07
Soil Survey		.....
Farm and Ranch Economics		128.72
Botany		4.82
Publications		4,948.60
State Apicultural Research Laboratory		709.75
Main Station Farm		882.03
Reverted to State Treasury		2,376.84

SUBSTATIONS

Stations	Debit	Credit
Total	$ 113,870.00	$ 113,870.00
Received from the State Treasurer	$ 113,870.00	
No. 1, Beeville		$ 4,533.98
2, Troup		4,739.21
3, Angleton		4,850.00
4, Beaumont		5,392.55
5, Temple		4,046.48
6, Denton		5,249.47
7, Spur		7,500.00
8, Lubbock		6,998.40
9, Balmorhea		5,922.02
10, Feeding and Breeding Station, College Station		7,349.73
Dairy section		2,598.11
Poultry section		2,479.60
Swine section		4,742.68
11, Nacogdoches		4,586.29
12, Chillicothe		4,686.07
14, Sonora		13,106.81
15, Weslaco		8,396.88
16, Iowa Park		8,617.34
Iowa Park (Emergency)		.....
Balance unexpended (vouchers pending)		8,074.38

SUBSTATIONS

Stations	Debit	Credit
Total	$ 3,389.91	$ 3,389.91
Received from the State Treasurer (unexpended balance from 1925-26 appropriation)	$ 3,389.91	
No. 1, Beeville		$ 250.07
2, Troup		154.99
4, Beaumont		320.29
5, Temple		.....
6, Denton		.....
7, Spur		.....
8, Lubbock		15.66
9, Balmorhea		109.33
10, Feeding and Breeding Station, College Station		.....
Dairy section		.....
Poultry section		206.21
Swine section		108.07
11, Nacogdoches		1.74
12, Chillicothe		.....
14, Sonora		207.28
15, Weslaco		499.80
16, Iowa Park		1,291.35
Reverted to State Treasury		225.12

SALES FUNDS

MAIN STATION TREASURY

Division	Debit	Credit
Total	$ 40,110.90	$ 40,110.90
Balance brought forward from previous year	$ 10,799.41	
Received from sales during year	29,311.49	
Veterinary Science		$ 949.85
Horticulture		183.78
Entomology		67.19
Agronomy		179.21
Plant Pathology and Physiology		3,010.24
Farm and Ranch Economics		998.45
Publications		87.26
State Apicultural Research Laboratory		379.61
Main Station Farm		3,135.27
Chemistry (Analysis Fund)		11,498.58
Photographic Laboratory		1,215.65
Sulphur Fund		2,930.78
Interest and Discount		922.82
Entomology Certificate Fund		53.75
Main Station Auto Fund		384.31
Farm Bureau Fund		29.80
Nitrate Fellowship Fund		719.24
Balance		13,365.11

SUBSTATION TREASURY

Station	Debit	Credit
Total	$ 96,727.11	$ 96,727.11
Balance brought forward from previous year	$ 19,117.11	
Received from sales during year	77,610.00	
No. 1, Beeville		$ 1,588.82
2, Troup		286.36
3, Angleton		801.36
4, Beaumont		594.19
5, Temple		606.61
6, Denton		1,895.77
7, Spur		9,581.36
8, Lubbock		5,048.47
9, Balmorhea		3,017.66
10, Feeding and Breeding Station, College Station		3,907.31
Dairy section		8,626.79
Poultry section		5,263.16
Swine section		7,904.89
11, Nacogdoches		214.49
12, Chillicothe		2,259.55
14, Sonora		12,743.06
15, Weslaco		3,051.22
16, Iowa Park		946.33
Soil Survey		1,962.28
Wool Scouring Plant		2,692.76
Administrative		595.21
Wichita Falls Chamber of Commerce Fund		180.00
Ten Per Cent Fund		.....
Tobacco By-Products Fund		15.00
Balance		22,944.46

FEED CONTROL SERVICE

Item	Debit	Credit
Total	$ 118,153.83	$ 118,153.83
Receipts		
Tax collected (inspection tax tags)	$ 118,153.83	
Disbursements		
Salaries		$ 22,184.96
Labor and wages		1,449.65
Stationery and office supplies		305.85
Sundry supplies		14,096.99
Communication service		417.11
Travel expenses		8,450.24
Transportation of things		7.31
Publications		1,216.44
Furniture and fixtures (office equipment)		34.80
Library		5.50
Refunded on redeemed tags		255.56
Chemical Analyses		12,916.63
Contingent		103.50
Net surplus		56,709.29

INVENTORY VALUATION

	Amount	Total
Grand total valuation of properties used by Agricultural Experiment Station System		$1,164,821.45
Owned by Station System and carried on Station Inventory	$ 995,371.76	
Owned by College proper and carried on College Inventory, but used by Station System for Station purposes	169,449.69	

STATION SYSTEM PROPERTY

	Amount	Total
Total Inventory Valuation		$ 995,371.76
Main Station	$ 241,850.37	
Substations	753,521.39	

MAIN STATION

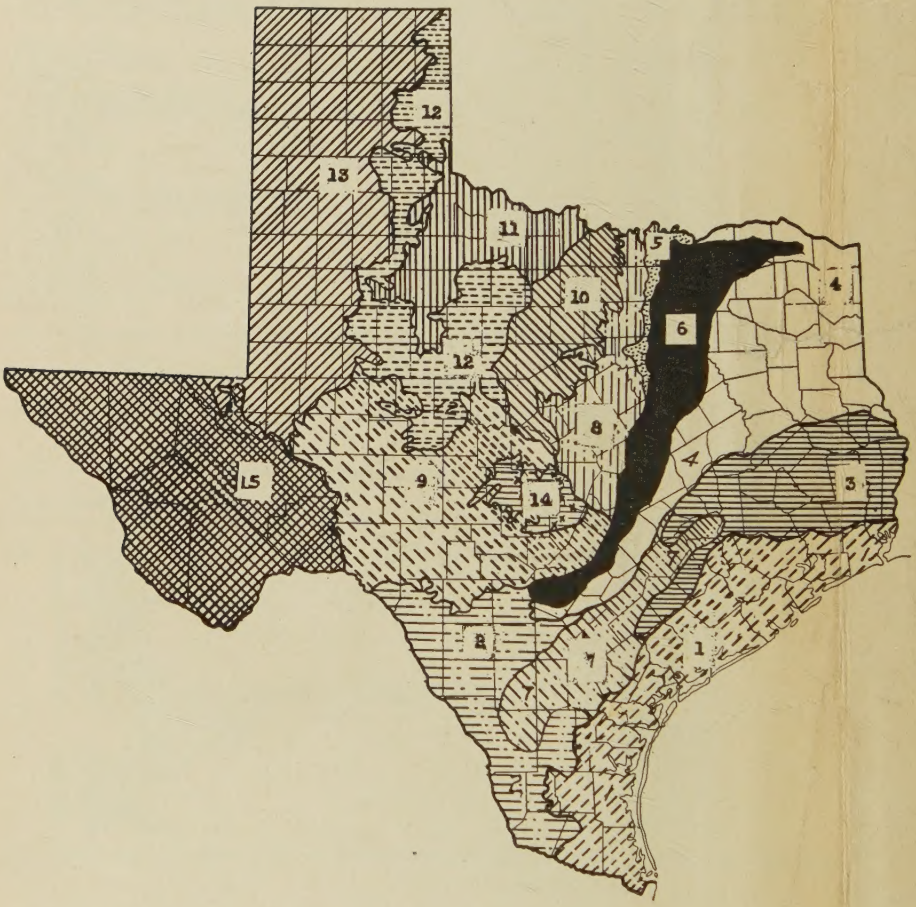
	Amount	Total
Total Inventory Valuation		$ 241,850.37
Administrative	$ 41,544.16	
Veterinary Science	33,377.29	
Chemistry	17,166.36	
Range Animal Husbandry	20,714.61	
Farm and Ranch Economics	3,699.45	
Agronomy	10,360.72	
Photographic	2,697.72	
Botany	1,918.94	
Entomology	11,474.10	
Plant Pathology and Physiology	8,233.71	
State Apicultural Research Laboratory	21,389.56	
Soil Survey	533.25	
Feed Control Service	3,148.94	
Horticulture	21,220.76	
Main Station Farm	35,542.37	
Rural Home Research	2,703.72	
Publications	6,124.71	

SUBSTATIONS

	Amount	Total
Total Inventory Valuation		$ 753,521.39
No. 1, Beeville	$ 26,544.05	
2, Troup	35,634.78	
3, Angleton	20,279.72	
4, Beaumont	30,948.73	
5, Temple	30,908.38	
6, Denton	41,359.82	
7, Spur	63,113.26	
8, Lubbock	36,423.14	
9, Balmorhea	29,495.50	
10, Feeding and Breeding Station, College Station	61,396.30	
Dairy section	23,215.90	
Poultry section	13,007.90	
Swine section	11,964.33	
11, Nacogdoches	25,155.96	
12, Chillicothe	28,101.45	
14, Sonora	131,840.05	
15, Weslaco	103,389.03	
16, Iowa Park	40,743.09	

SOIL REGIONS OF TEXAS

(Prepared by W. T. Carter)



1. Gulf Coast Prairie
2. Rio Grande Plain
3. Flatwoods Region
4. East Texas Timber Country
5. Eastern Cross Timbers
6. Black Waxy Prairie Lands
7. Interior Black Prairie Lands
8. Fort Worth Prairie and Lampasas Cut Plain
9. Edwards Plateau
10. Western Cross Timbers and Association Interior Prairies
11. Northwest Texas Red Lands
12. Northwest Texas Dark Soils
13. High Plains (Llano Estacado)
14. Central Mineral Basin
15. Trans Pecos Region (Mountains and Plains)